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Yoshinaga et al.

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(45) **Date of Patent: Mar. 15, 2016**

(54) **IMAGE FORMING APPARATUS INCLUDING A HEAT SHIELD INTERPOSED BETWEEN A HEATER AND A FIXING ROTARY BODY AND IMAGE FORMING METHOD**

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G03G 15/20 (2006.01)

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CPC ***G03G 15/2039*** (2013.01); ***G03G 15/2053*** (2013.01); *G03G 15/2042* (2013.01); *G03G 15/55* (2013.01); *G03G 2215/2035* (2013.01)

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See application file for complete search history.

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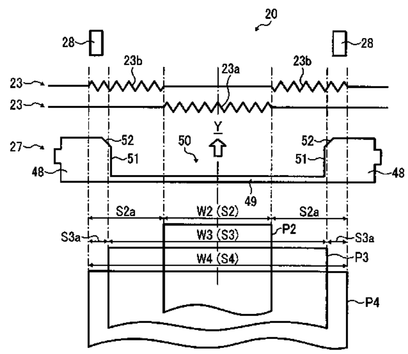
(57) **ABSTRACT**

An image forming apparatus includes a fixing device including a fixing rotary body and a heater for heating the fixing rotary body. An opposed body contacts the fixing rotary body with releasable pressure therebetween to form a fixing nip therebetween through which a recording medium is conveyed. A heat shield is interposed between the heater and the fixing rotary body and movable in a circumferential direction of the fixing rotary body to shield the fixing rotary body from the heater in a variable circumferential direct heating span of the fixing rotary body where the heater is disposed opposite the fixing rotary body directly. A controller halts the heat shield instantly when a fault occurs during a print job.

20 Claims, 16 Drawing Sheets



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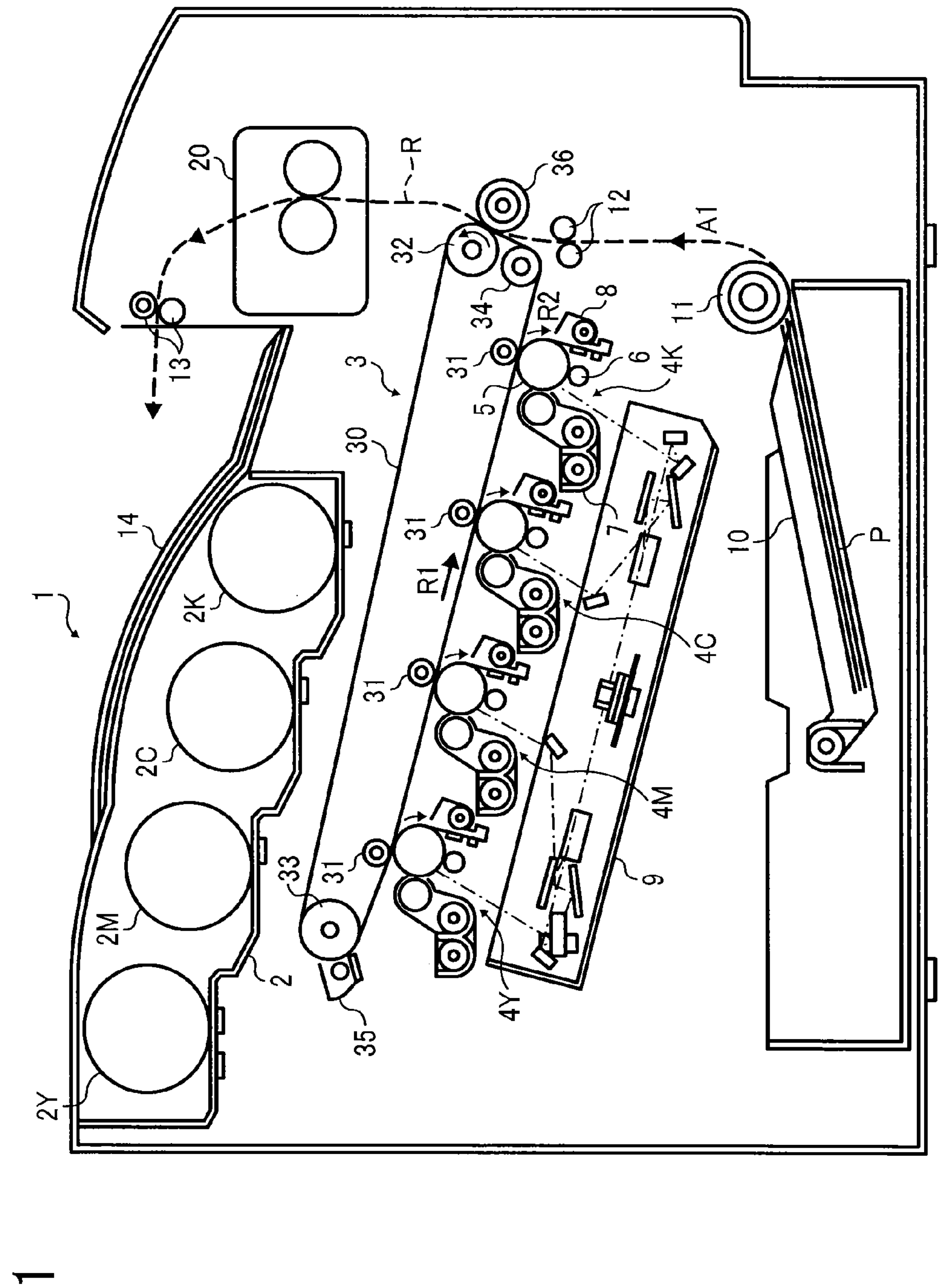
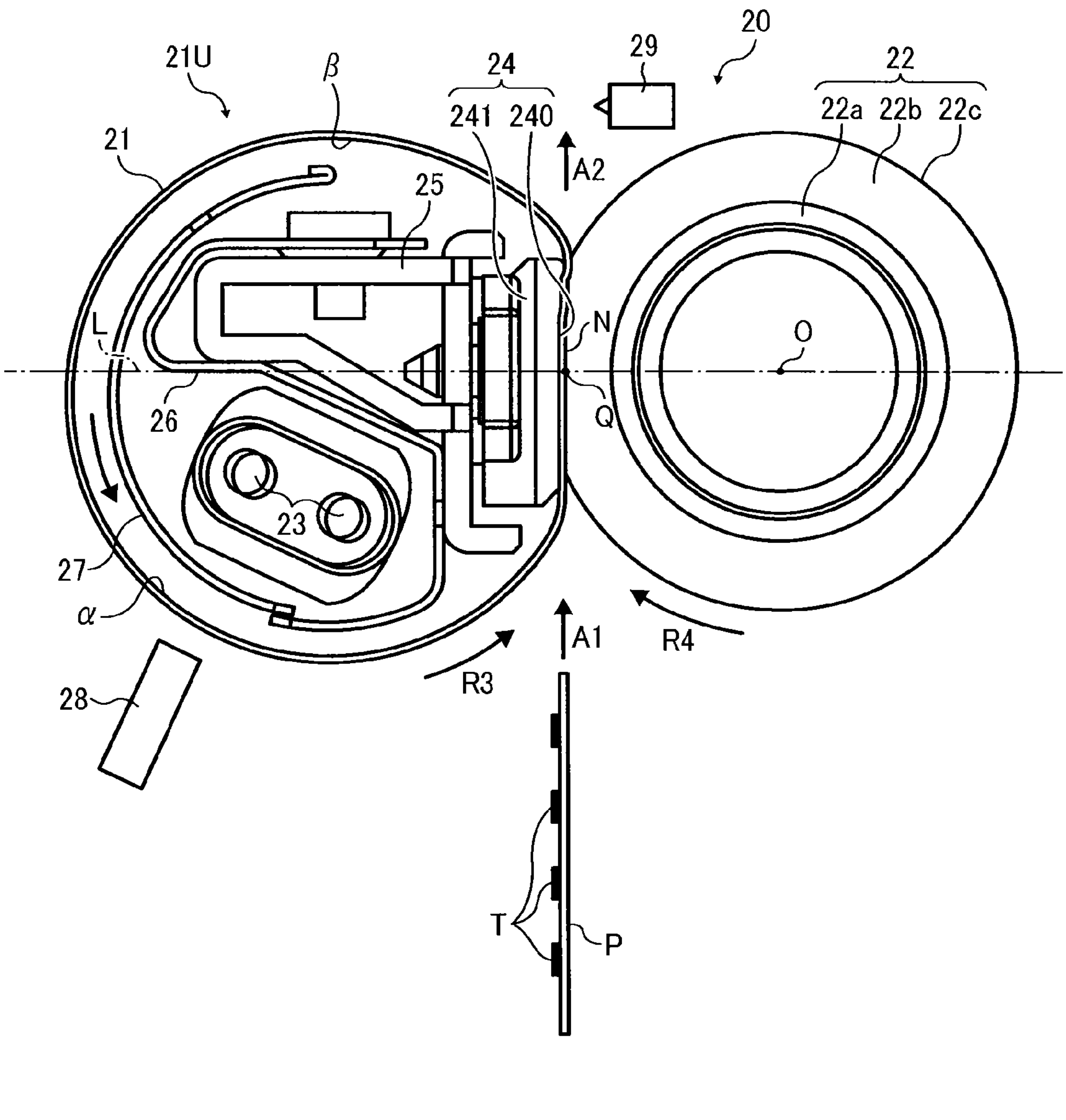

1
2
2Y
2M
2C
2K
3
4Y
4M
4C
4K
5
6
7
8
9
10
11
12
13
14
20
30
31
32
33
34
35
36
A1
P
R
R1
R2

FIG. 1

FIG. 2



20
21U
21
β
24
241
240
29
22
22a
22b
22c
A2
25
N
O
L
Q
26
23
27
α
A1
R3
R4
28
T
P

FIG. 3

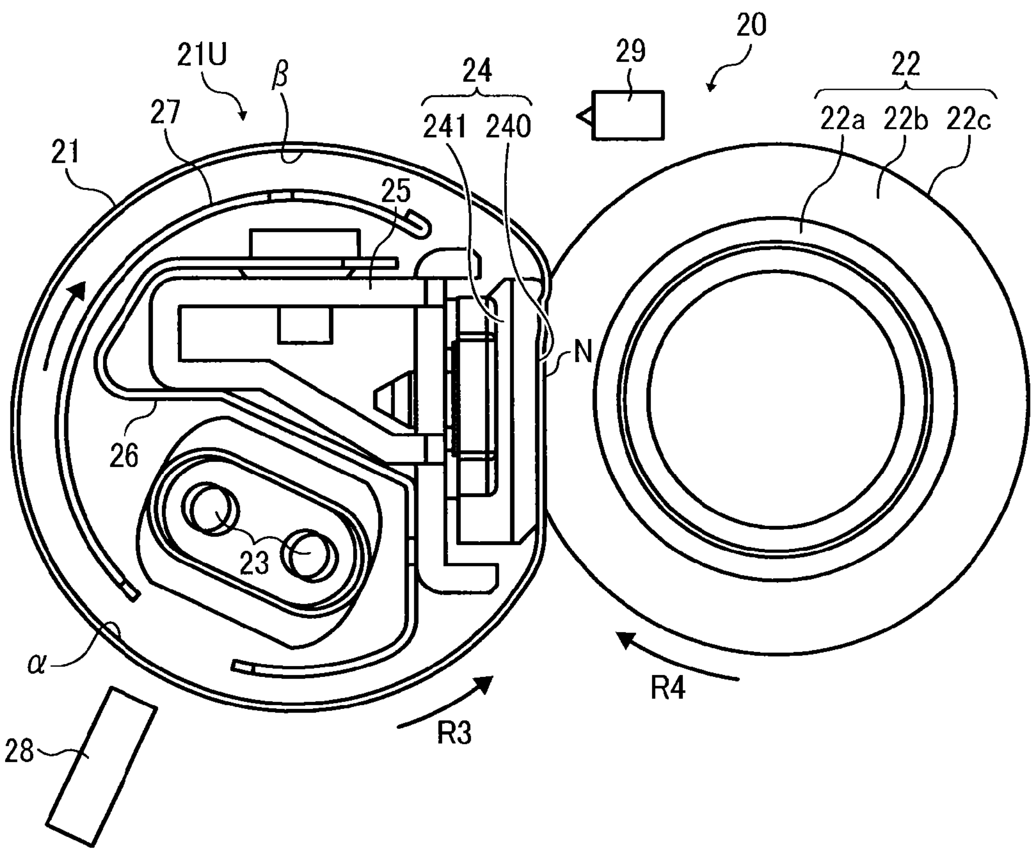


FIG. 4

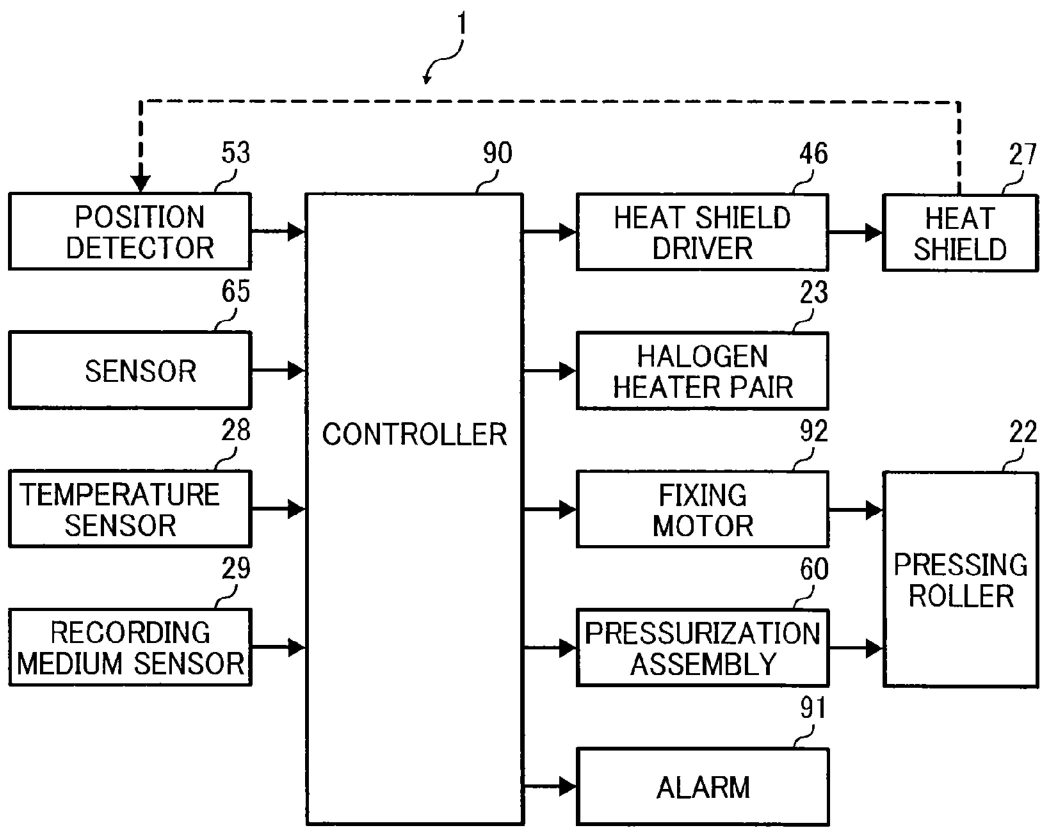

1
53
POSITION DETECTOR
65
SENSOR
28
TEMPERATURE SENSOR
29
RECORDING MEDIUM SENSOR
90
CONTROLLER
46
HEAT SHIELD DRIVER
23
HALOGEN HEATER PAIR
92
FIXING MOTOR
60
PRESSURIZATION ASSEMBLY
91
ALARM
27
HEAT SHIELD
22
PRESSING ROLLER

FIG. 5

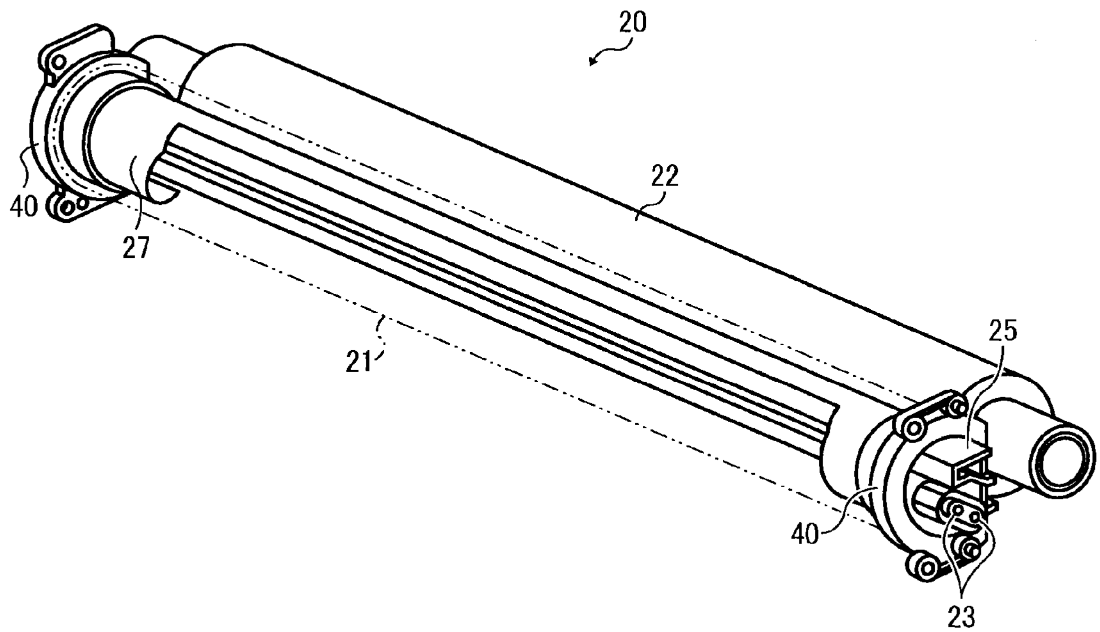


FIG. 6

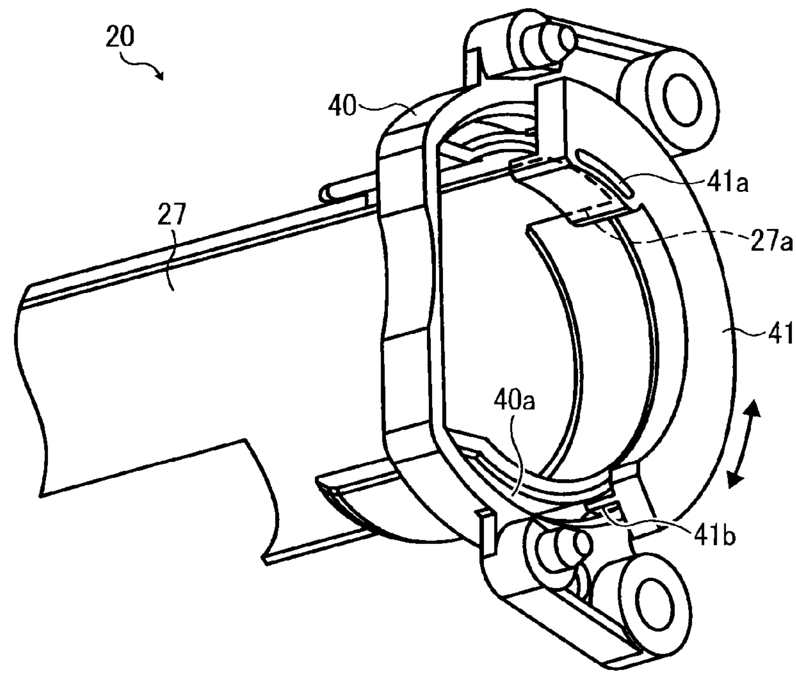


FIG. 7

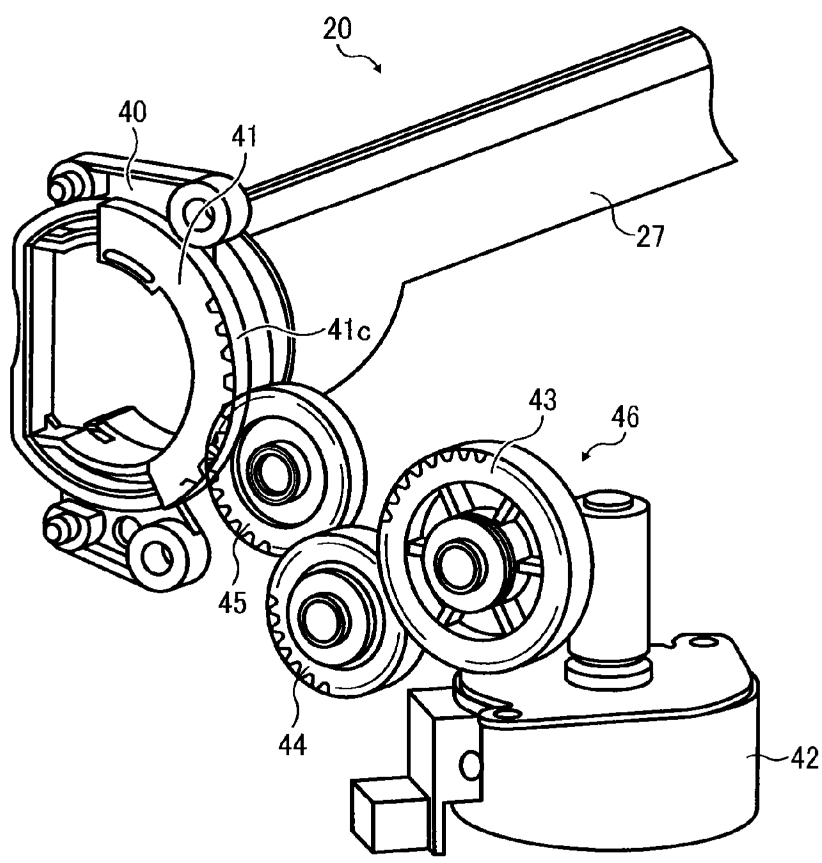


FIG. 8

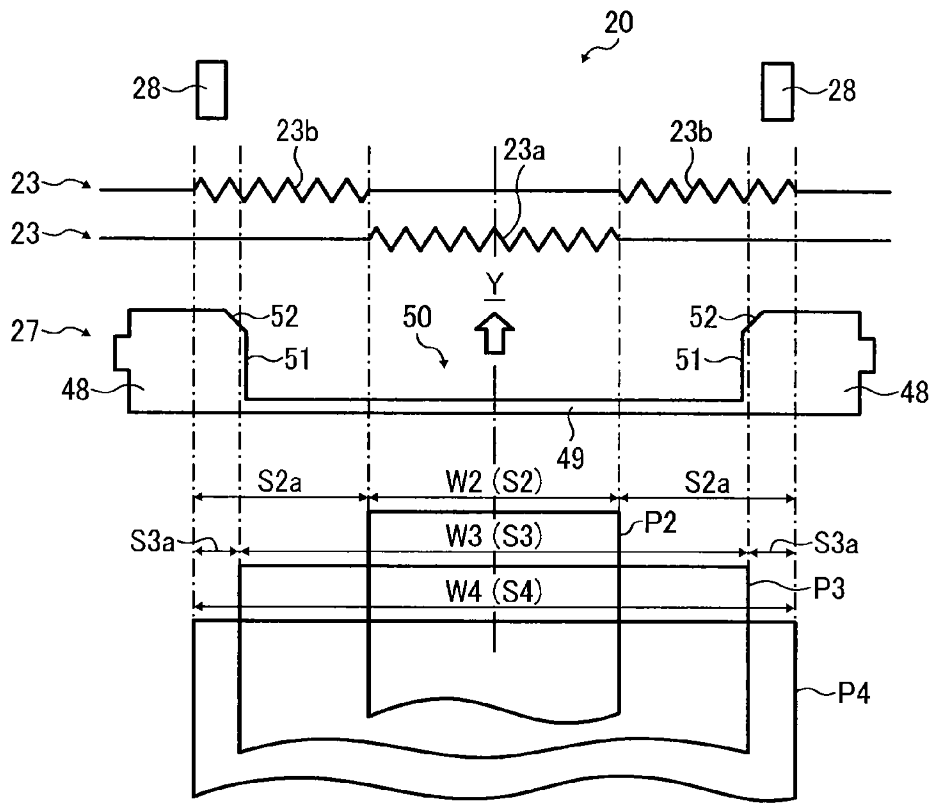

20
28
28
23b
23a
23b
23
23
Y
27
52
50
52
51
51
48
48
49
S2a
W2 (S2)
S2a
P2
S3a
W3 (S3)
S3a
P3
W4 (S4)
P4

FIG. 9

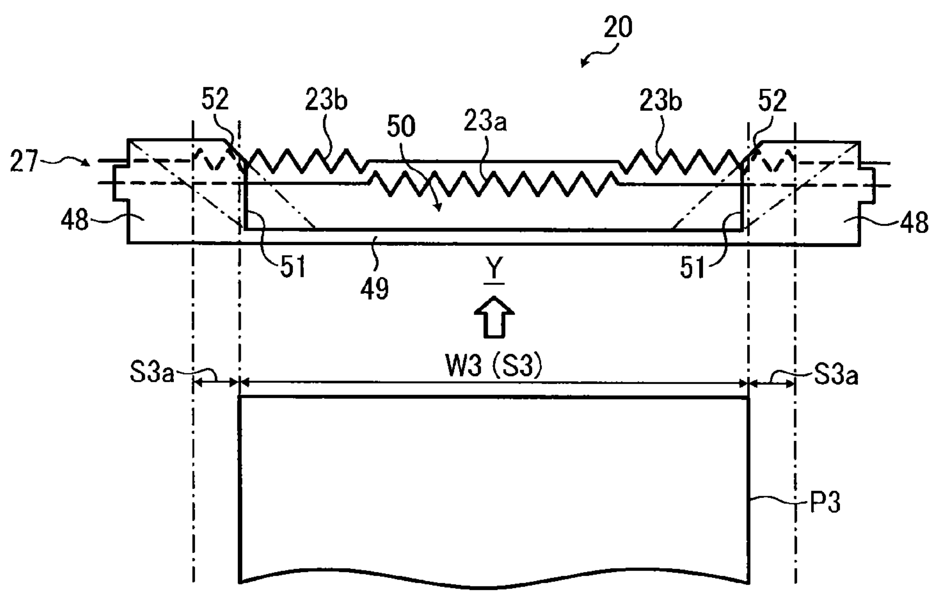
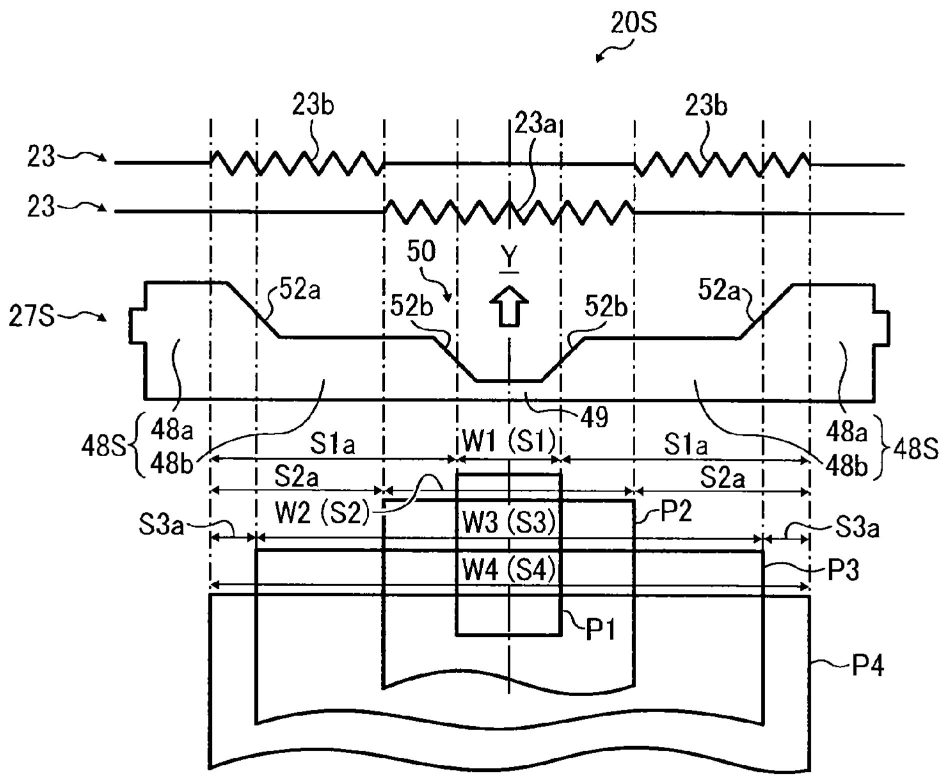
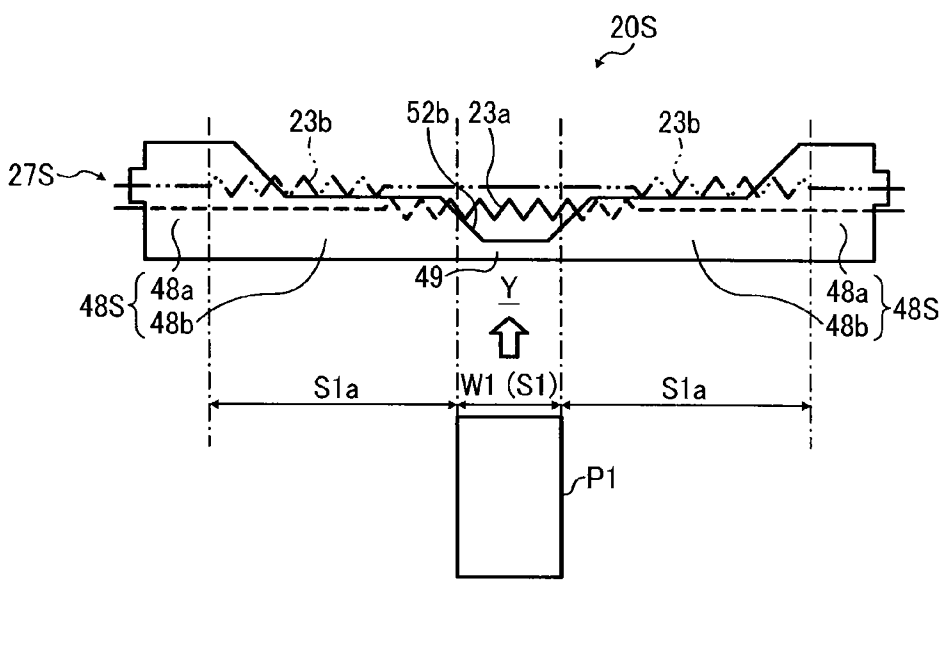

20
52
23b
50
23a
23b
52
27
48
48
51
49
51
Y
S3a
W3 (S3)
S3a
P3

FIG. 10



20S
23b
23a
23b
23
23
50
Y
27S
52a
52b
52b
52a
49
48S
48a
48b
48a
48b
48S
S1a
W1 (S1)
S1a
S2a
S2a
W2 (S2)
P2
W3 (S3)
S3a
S3a
W4 (S4)
P3
P1
P4

FIG. 11



20S
27S
23b
52b
23a
23b
49
Y
48S
48a
48b
48a
48b
48S
S1a
W1 (S1)
S1a
P1

FIG. 12A

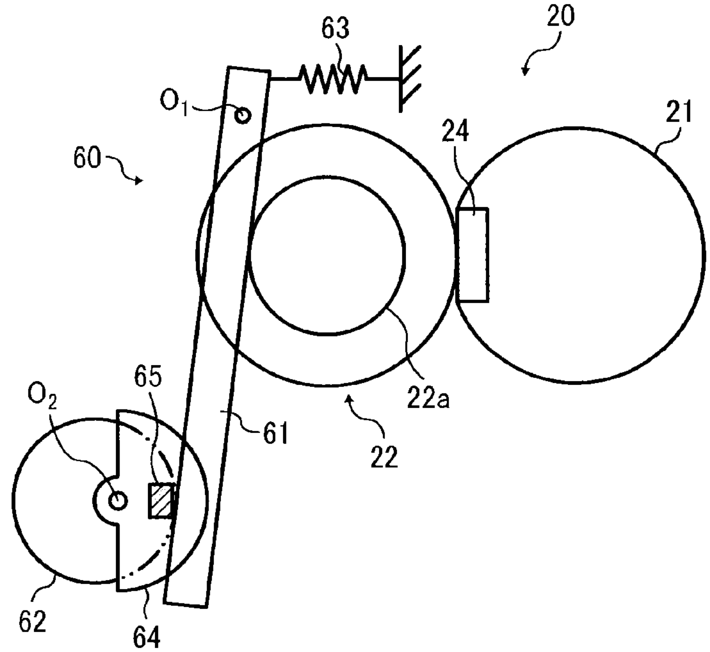


FIG. 12B

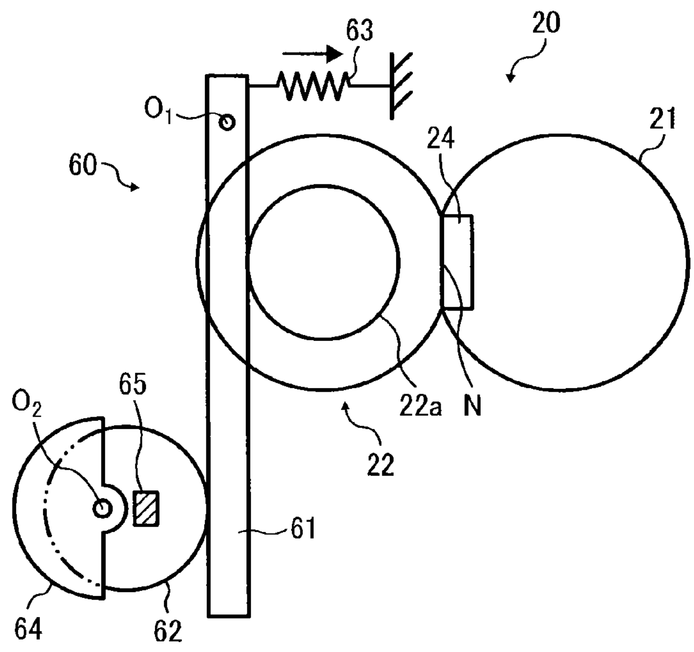


FIG. 13A

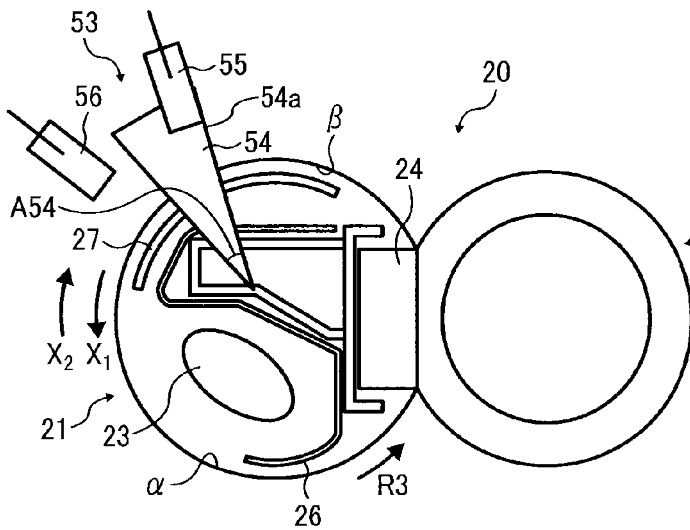


FIG. 13B

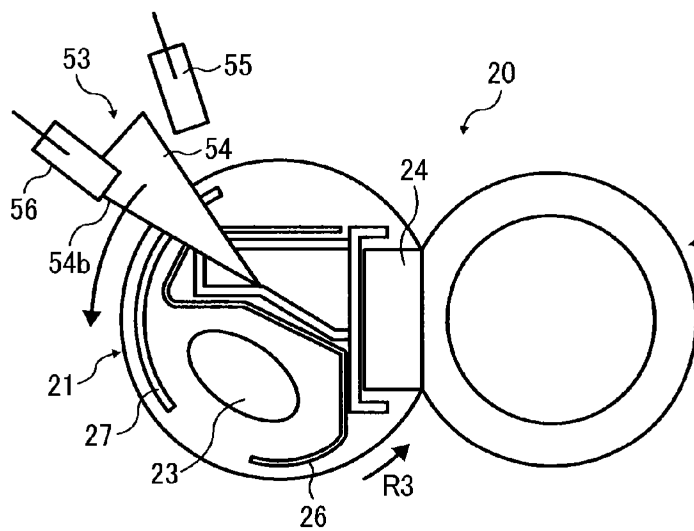


FIG. 13C

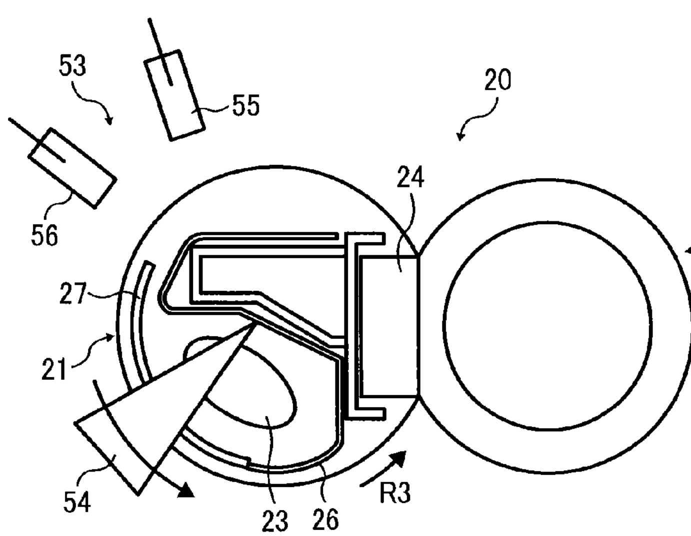


FIG. 14

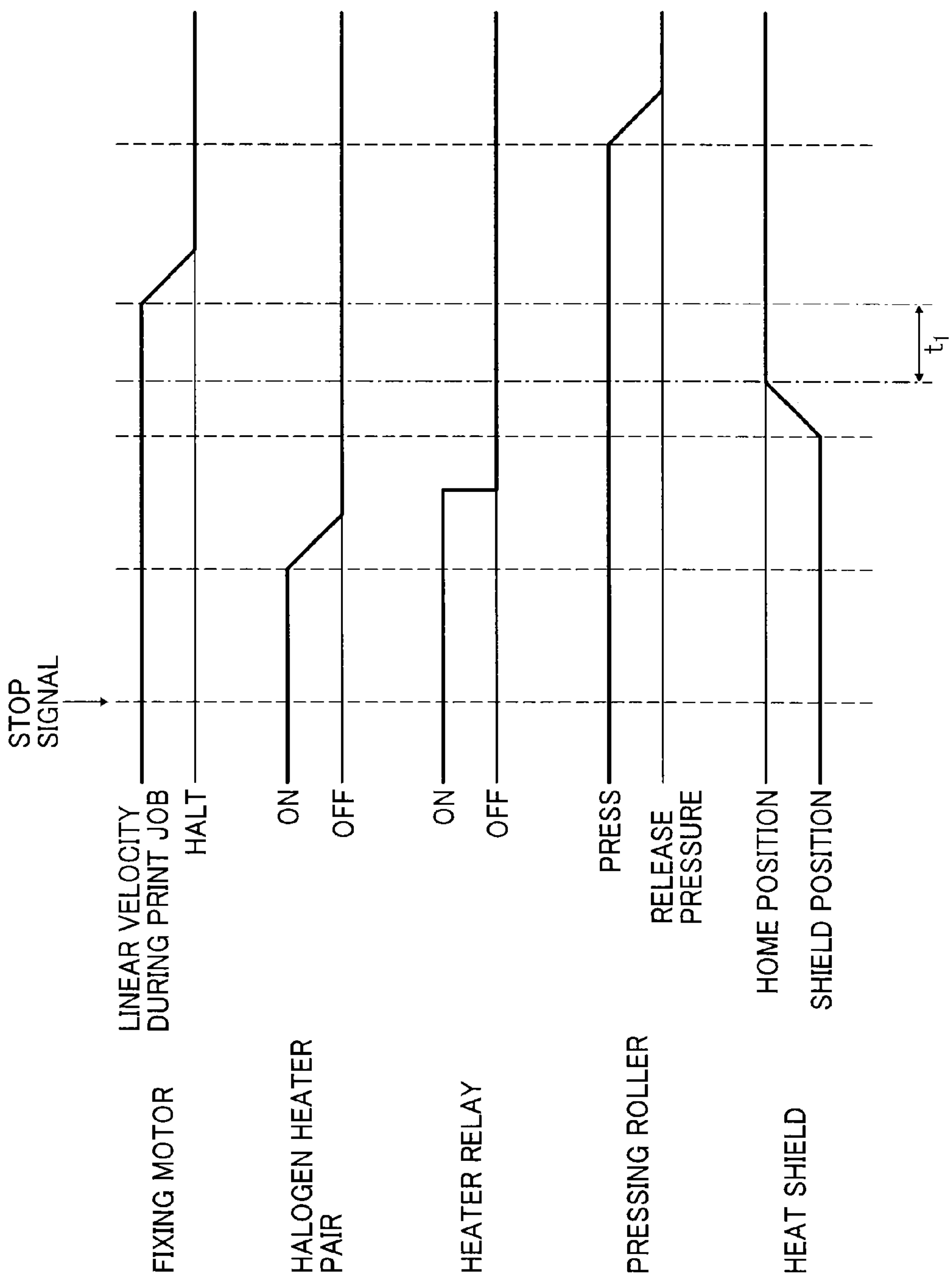
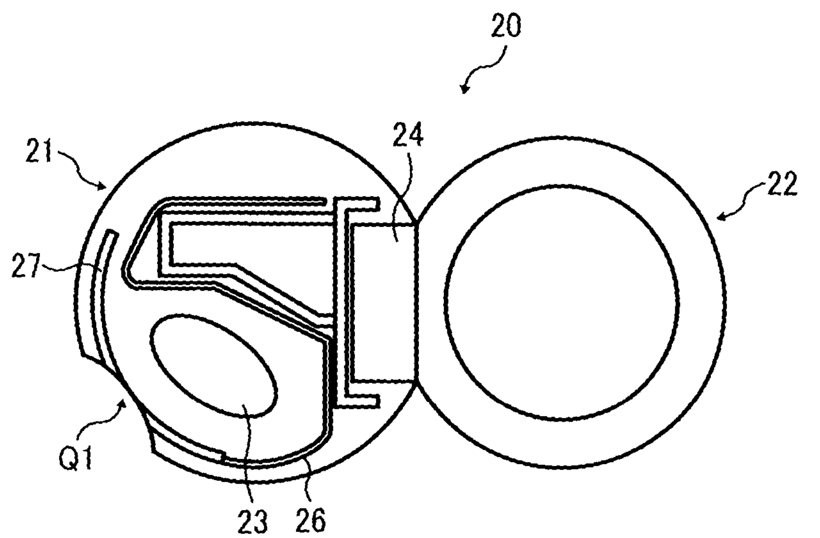

STOP SIGNAL
FIXING MOTOR
LINEAR VELOCITY DURING PRINT JOB
HALT
HALOGEN HEATER PAIR
ON
OFF
HEATER RELAY
ON
OFF
PRESSING ROLLER
PRESS
RELEASE PRESSURE
HEAT SHIELD
HOME POSITION
SHIELD POSITION
t_1

FIG. 15



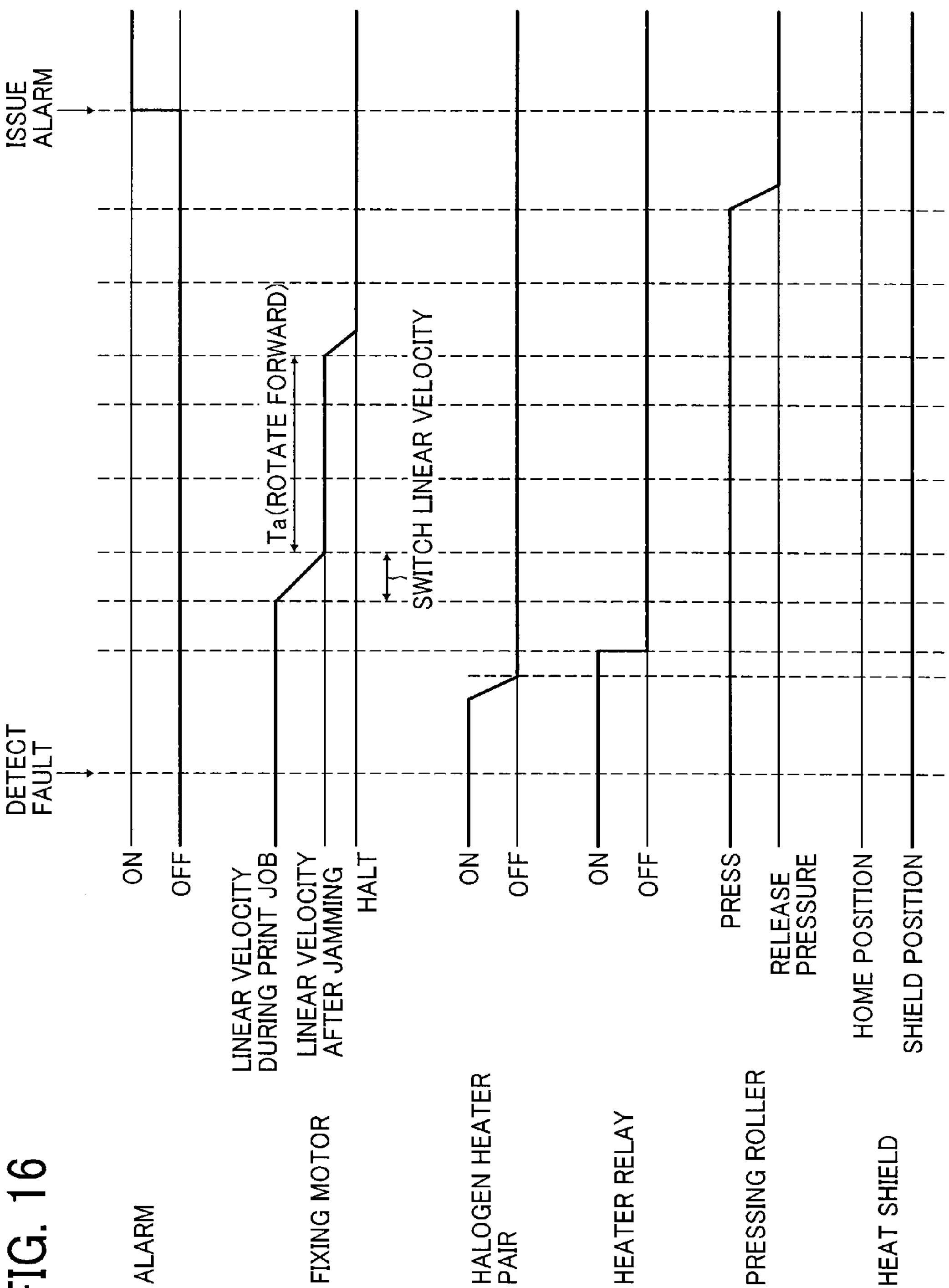

ALARM
ON
OFF
FIXING MOTOR
LINEAR VELOCITY DURING PRINT JOB
LINEAR VELOCITY AFTER JAMMING
HALT
HALOGEN HEATER PAIR
ON
OFF
HEATER RELAY
ON
OFF
PRESSING ROLLER
PRESS
RELEASE PRESSURE
HEAT SHIELD
HOME POSITION
SHIELD POSITION
DETECT FAULT
ISSUE ALARM
Ta (ROTATE FORWARD)
SWITCH LINEAR VELOCITY

FIG. 16

FIG. 17

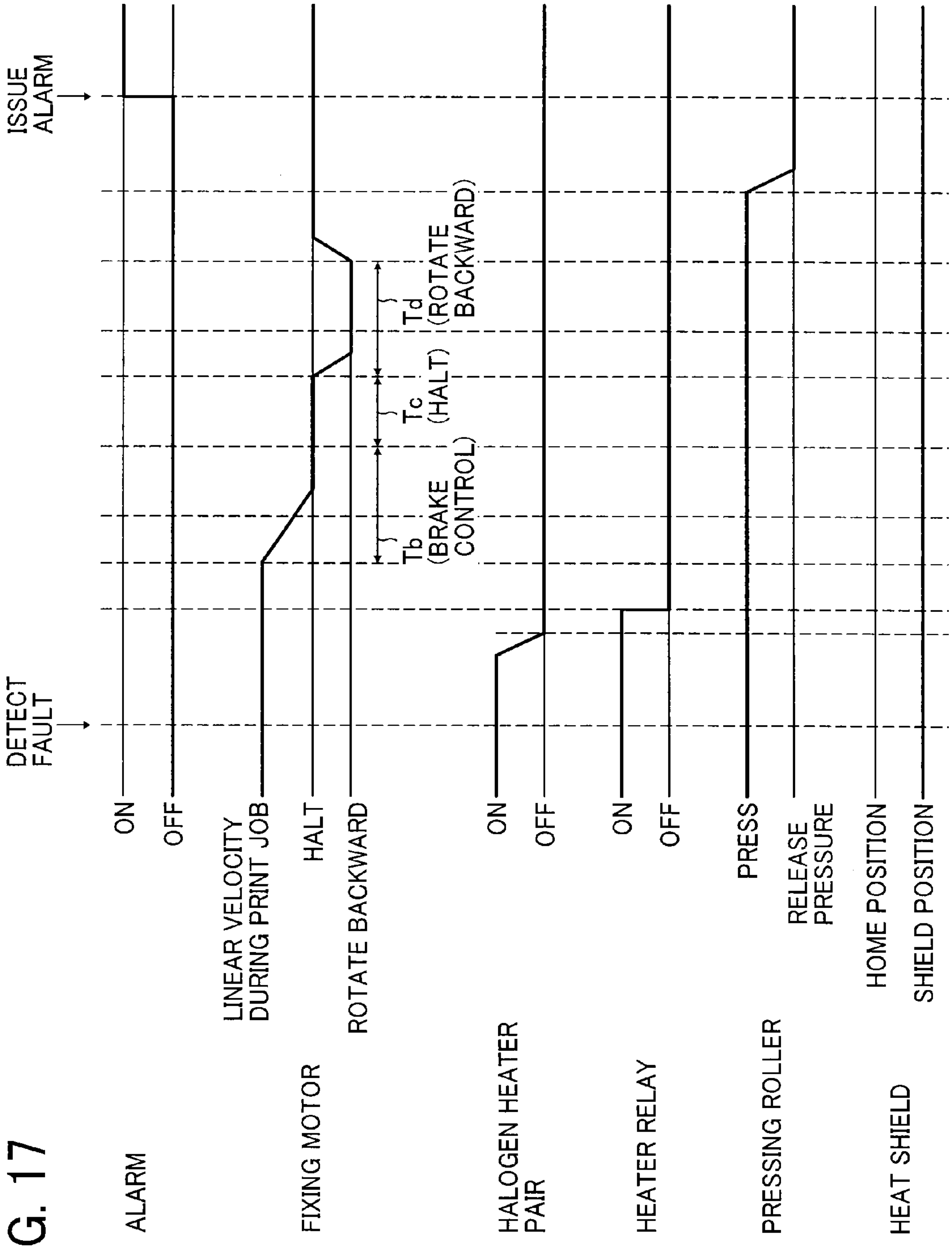

ISSUE ALARM
DETECT FAULT
ALARM
ON
OFF
FIXING MOTOR
LINEAR VELOCITY DURING PRINT JOB
HALT
ROTATE BACKWARD
Tb (BRAKE CONTROL)
Tc (HALT)
Td (ROTATE BACKWARD)
HALOGEN HEATER PAIR
ON
OFF
HEATER RELAY
ON
OFF
PRESSING ROLLER
PRESS
RELEASE PRESSURE
HEAT SHIELD
HOME POSITION
SHIELD POSITION

FIG. 18

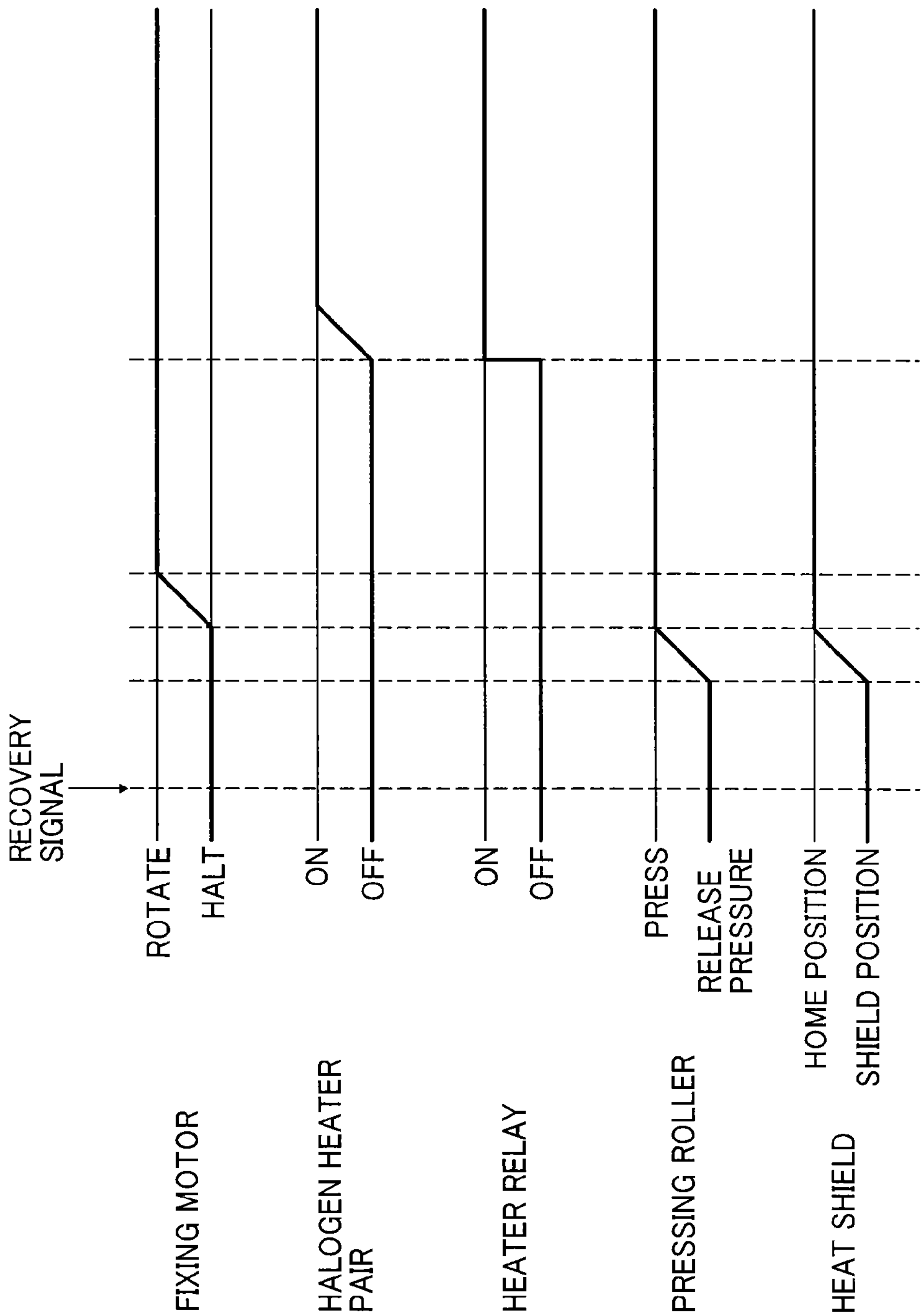

RECOVERY SIGNAL
FIXING MOTOR
ROTATE
HALT
HALOGEN HEATER PAIR
ON
OFF
HEATER RELAY
ON
OFF
PRESSING ROLLER
PRESS
RELEASE PRESSURE
HEAT SHIELD
HOME POSITION
SHIELD POSITION

FIG. 19

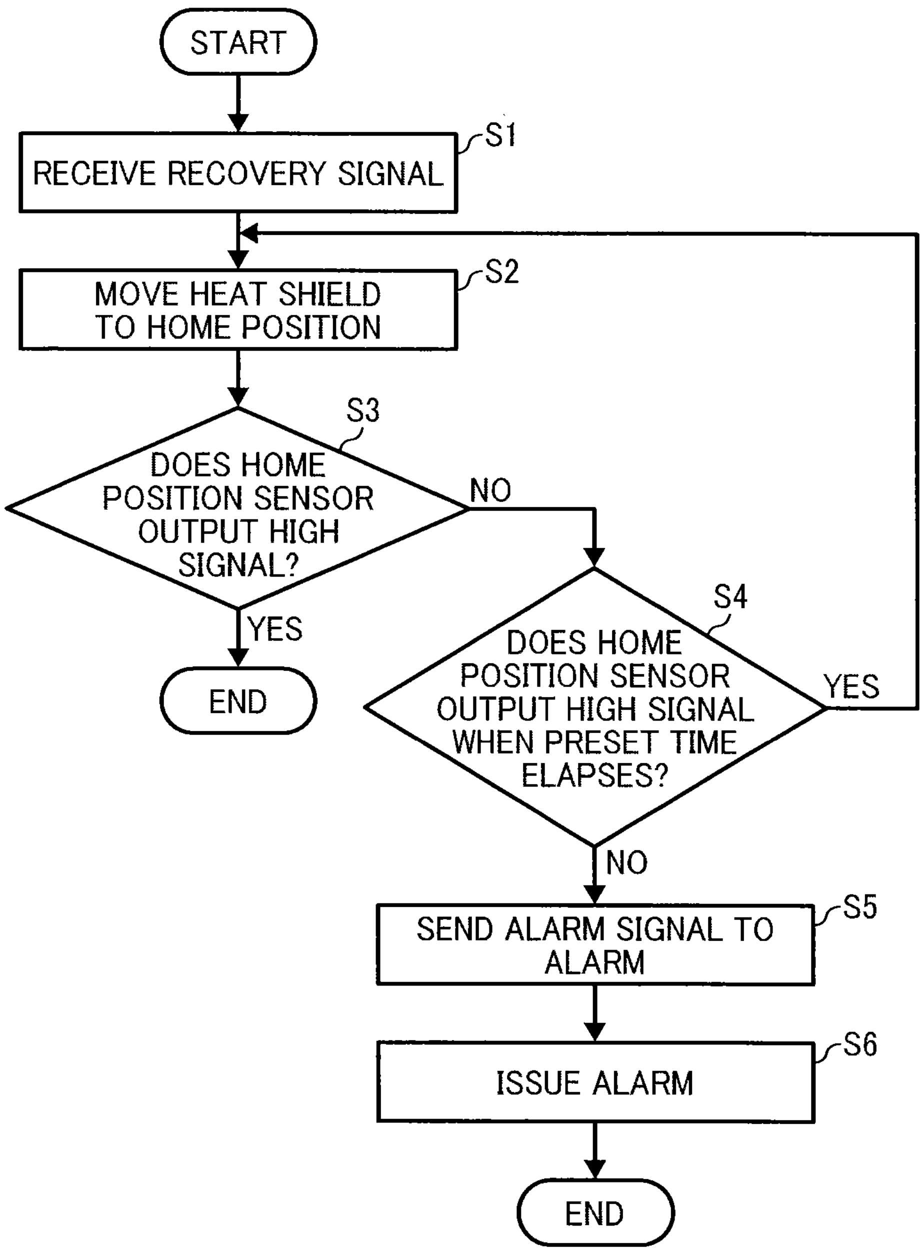

START
RECEIVE RECOVERY SIGNAL
S1
MOVE HEAT SHIELD TO HOME POSITION
S2
DOES HOME POSITION SENSOR OUTPUT HIGH SIGNAL?
S3
NO
YES
END
DOES HOME POSITION SENSOR OUTPUT HIGH SIGNAL WHEN PRESET TIME ELAPSES?
S4
YES
NO
SEND ALARM SIGNAL TO ALARM
S5
ISSUE ALARM
S6
END

IMAGE FORMING APPARATUS INCLUDING A HEAT SHIELD INTERPOSED BETWEEN A HEATER AND A FIXING ROTARY BODY AND IMAGE FORMING METHOD

CROSS-REFERENCE TO RELATED APPLICATION

This patent application is based on and claims priority pursuant to 35 U.S.C. §119 to Japanese Patent Application No. 2013-053686, filed on Mar. 15, 2013, in the Japanese Patent Office, the entire disclosure of which is hereby incorporated by reference herein.

BACKGROUND

1. Technical Field

Exemplary aspects of the present invention relate to an image forming apparatus and an image forming method, and more particularly, to an image forming apparatus for forming a toner image on a recording medium and an image forming method performed by the image forming apparatus.

2. Description of the Background

Related-art image forming apparatuses, such as copiers, facsimile machines, printers, or multifunction printers having two or more of copying, printing, scanning, facsimile, plotter, and other functions, typically form an image on a recording medium according to image data. Thus, for example, a charger uniformly charges a surface of a photoconductor; an optical writer emits a light beam onto the charged surface of the photoconductor to form an electrostatic latent image on the photoconductor according to the image data; a development device supplies toner to the electrostatic latent image formed on the photoconductor to render the electrostatic latent image visible as a toner image; the toner image is directly transferred from the photoconductor onto a recording medium or is indirectly transferred from the photoconductor onto a recording medium via an intermediate transfer belt; finally, a fixing device applies heat and pressure to the recording medium bearing the toner image to fix the toner image on the recording medium, thus forming the image on the recording medium.

Such fixing device may include a fixing rotary body heated by a heater and an opposed body contacting the fixing rotary body to form a fixing nip therebetween through which a recording medium bearing a toner image is conveyed. As the fixing rotary body and the opposed body rotate and convey the recording medium bearing the toner image through the fixing nip, the fixing rotary body heated to a predetermined fixing temperature and the opposed body together heat and melt toner of the toner image, thus fixing the toner image on the recording medium.

Since the recording medium passing through the fixing nip draws heat from the fixing rotary body, a temperature sensor detects the temperature of the fixing rotary body to maintain the fixing rotary body at a desired temperature. Conversely, at each lateral end of the fixing rotary body in an axial direction thereof, the recording medium is not conveyed over the fixing rotary body and therefore does not draw heat from the fixing rotary body. Accordingly, after a plurality of recording media is conveyed through the fixing nip continuously, a non-conveyance span situated at each lateral end of the fixing rotary body may overheat.

To address this circumstance, the fixing device may incorporate a heat shield to shield the non-conveyance span of the fixing rotary body from the heater, thus preventing overheating of the fixing rotary body as disclosed by JP-2008-058833-A and JP-2008-139779-A, for example. The heat shield is movable to shield the fixing rotary body from the heater in a variable span on the fixing rotary body according to the size of the recording medium. For example, the heat shield moves from a home position where the heat shield does not shield the fixing rotary body from the heater to a shield position where the heat shield shields the fixing rotary body from the heater.

Incidentally, the image forming apparatus may stop urgently when a fault occurs, for example, when the recording medium is jammed between the fixing rotary body and the opposed body. When the fault occurs, the heat shield returns to the home position. Accordingly, the fixing device may stop with delay, resulting damage to the components including the fixing rotary body that are incorporated in the fixing device.

SUMMARY

This specification describes an improved image forming apparatus. In one exemplary embodiment, the image forming apparatus includes a fixing device including a fixing rotary body rotatable in a predetermined direction of rotation and a heater disposed opposite and heating the fixing rotary body. An opposed body contacts the fixing rotary body with releasable pressure therebetween to form a fixing nip therebetween through which a recording medium is conveyed. A heat shield is interposed between the heater and the fixing rotary body and movable in a circumferential direction of the fixing rotary body to shield the fixing rotary body from the heater in a variable circumferential direct heating span of the fixing rotary body where the heater is disposed opposite the fixing rotary body directly. A controller is operatively connected to the heater and the heat shield to halt the heat shield instantly when a fault occurs during a print job.

This specification further describes an improved image forming method. In one exemplary embodiment, the image forming method includes rotating a fixing rotary body forward at an increased linear velocity to convey a recording medium through a fixing nip formed between the fixing rotary body and an opposed body contacted by the fixing rotary body with pressure therebetween; moving a heat shield to a shield position where the heat shield shields the fixing rotary body from a heater; detecting a fault; detecting the recording medium discharged from the fixing nip; turning off the heater; rotating the fixing rotary body forward at a decreased linear velocity for a preset time; halting the fixing rotary body; releasing the pressure between the fixing rotary body and the opposed body; and issuing an alarm about the fault.

This specification further describes an improved image forming method. In one exemplary embodiment, the image forming method includes rotating a fixing rotary body forward at an increased linear velocity to convey a recording medium through a fixing nip formed between the fixing rotary body and an opposed body contacted by the fixing rotary body with pressure therebetween; moving a heat shield to a shield position where the heat shield shields the fixing rotary body from a heater; detecting a fault; detecting no recording medium discharged from the fixing nip; turning off the heater; halting the fixing rotary body for a preset first time; rotating the fixing rotary body backward for a preset second time; halting the fixing rotary body; releasing the pressure between the fixing rotary body and the opposed body; and issuing an alarm about the fault.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of the invention and the many attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

FIG. **1** is a schematic vertical sectional view of an image forming apparatus according to an exemplary embodiment of the present invention;

FIG. **2** is a vertical sectional view of a fixing device incorporated in the image forming apparatus shown in FIG. **1** illustrating a heat shield incorporated therein that is situated at a shield position;

FIG. **3** is a vertical sectional view of the fixing device shown in FIG. **2** illustrating the heat shield situated at a retracted position;

FIG. **4** is a block diagram of the image forming apparatus shown in FIG. **1**;

FIG. **5** is a partial perspective view of the fixing device shown in FIG. **3**;

FIG. **6** is a partial perspective view of the fixing device shown in FIG. **2** illustrating one lateral end of the heat shield in an axial direction thereof;

FIG. **7** is a partial perspective view of the fixing device shown in FIG. **2** illustrating a heat shield driver incorporated therein;

FIG. **8** is a schematic diagram of the fixing device shown in FIG. **3** illustrating a halogen heater pair incorporated therein, the heat shield, and recording media of various sizes;

FIG. **9** is a partial schematic diagram of the fixing device shown in FIG. **2** illustrating the heat shield at the shield position;

FIG. **10** is a schematic diagram of a fixing device according to another exemplary embodiment;

FIG. **11** is a partial schematic diagram of the fixing device shown in FIG. **10** illustrating a heat shield incorporated therein that is situated at the shield position;

FIG. **12**A is a vertical sectional view of the fixing device shown in FIG. **2** illustrating a pressurization assembly separating a pressing roller from a fixing belt;

FIG. **12**B is a vertical sectional view of the fixing device shown in FIG. **2** illustrating the pressurization assembly pressing the pressing roller against the fixing belt;

FIG. **13**A is a vertical sectional view of the fixing device shown in FIG. **2** illustrating a position detector incorporated therein that is situated at a home position;

FIG. **13**B is a vertical sectional view of the fixing device shown in FIG. **13**A illustrating the position detector situated at a reference position;

FIG. **13**C is a vertical sectional view of the fixing device shown in FIG. **13**A illustrating the position detector situated at the shield position;

FIG. **14** is a timing chart illustrating operation of components incorporated in the fixing device shown in FIG. **2**;

FIG. **15** is a partial vertical sectional view of the fixing device shown in FIG. **2** illustrating deformation of the fixing belt;

FIG. **16** is a timing chart illustrating operation of the components of the fixing device shown in FIG. **2** when a recording medium sensor incorporated therein detects a recording medium;

FIG. **17** is a timing chart illustrating operation of the components of the fixing device shown in FIG. **2** when the recording medium sensor does not detect the recording medium;

FIG. **18** is a timing chart illustrating processes performed by the components of the fixing device shown in FIG. **2** as the image forming apparatus shown in FIG. **1** is turned on for recovery; and

FIG. **19** is a flowchart showing the processes shown in FIG. **18** to return the heat shield to the home position shown in FIG. **13**A as the image forming apparatus is turned on for recovery.

DETAILED DESCRIPTION OF THE INVENTION

In describing exemplary embodiments illustrated in the drawings, specific terminology is employed for the sake of clarity. However, the disclosure of this specification is not intended to be limited to the specific terminology so selected and it is to be understood that each specific element includes all technical equivalents that operate in a similar manner and achieve a similar result.

Referring now to the drawings, wherein like reference numerals designate identical or corresponding parts throughout the several views, in particular to FIG. **1**, an image forming apparatus **1** according to an exemplary embodiment of the present invention is explained.

FIG. **1** is a schematic vertical sectional view of the image forming apparatus **1**. The image forming apparatus **1** may be a copier, a facsimile machine, a printer, a multifunction peripheral or a multifunction printer (MFP) having at least one of copying, printing, scanning, facsimile, and plotter functions, or the like. According to this exemplary embodiment, the image forming apparatus **1** is a color laser printer that forms color and monochrome toner images on recording media by electrophotography.

As shown in FIG. **1**, the image forming apparatus **1** includes four image forming devices **4**Y, **4**M, **4**C, and **4**K situated in a center portion thereof. Although the image forming devices **4**Y, **4**M, **4**C, and **4**K contain yellow, magenta, cyan, and black developers (e.g., toners) that form yellow, magenta, cyan, and black toner images, respectively, resulting in a color toner image, they have an identical structure.

For example, each of the image forming devices **4**Y, **4**M, **4**C, and **4**K includes a drum-shaped photoconductor **5** serving as an image carrier that carries an electrostatic latent image and a resultant toner image; a charger **6** that charges an outer circumferential surface of the photoconductor **5**; a development device **7** that supplies toner to the electrostatic latent image formed on the outer circumferential surface of the photoconductor **5**, thus visualizing the electrostatic latent image as a toner image; and a cleaner **8** that cleans the outer circumferential surface of the photoconductor **5**. It is to be noted that, in FIG. **1**, reference numerals are assigned to the photoconductor **5**, the charger **6**, the development device **7**, and the cleaner **8** of the image forming device **4**K that forms a black toner image. However, reference numerals for the image forming devices **4**Y, **4**M, and **4**C that form yellow, magenta, and cyan toner images, respectively, are omitted.

Below the image forming devices **4**Y, **4**M, **4**C, and **4**K is an exposure device **9** that exposes the outer circumferential surface of the respective photoconductors **5** with laser beams. For example, the exposure device **9**, constructed of a light source, a polygon mirror, an f-θ lens, reflection mirrors, and the like, emits a laser beam onto the outer circumferential surface of the respective photoconductors **5** according to image data sent from an external device such as a client computer.

Above the image forming devices **4**Y, **4**M, **4**C, and **4**K is a transfer device **3**. For example, the transfer device **3** includes an intermediate transfer belt **30** serving as an intermediate transferor, four primary transfer rollers **31** serving as primary transferors, a secondary transfer roller **36** serving as a secondary transferor, a secondary transfer backup roller **32**, a cleaning backup roller **33**, a tension roller **34**, and a belt cleaner **35**.

The intermediate transfer belt **30** is an endless belt stretched taut across the secondary transfer backup roller **32**, the cleaning backup roller **33**, and the tension roller **34**. As a driver drives and rotates the secondary transfer backup roller **32** counterclockwise in FIG. **1**, the secondary transfer backup roller **32** rotates the intermediate transfer belt **30** counterclockwise in FIG. **1** in a rotation direction R**1** by friction therebetween.

The four primary transfer rollers **31** sandwich the intermediate transfer belt **30** together with the four photoconductors **5**, respectively, forming four primary transfer nips between the intermediate transfer belt **30** and the photoconductors **5**. The primary transfer rollers **31** are connected to a power supply that applies a predetermined direct current voltage and/or alternating current voltage thereto.

The secondary transfer roller **36** sandwiches the intermediate transfer belt **30** together with the secondary transfer backup roller **32**, forming a secondary transfer nip between the secondary transfer roller **36** and the intermediate transfer belt **30**. Similar to the primary transfer rollers **31**, the secondary transfer roller **36** is connected to the power supply that applies a predetermined direct current voltage and/or alternating current voltage thereto.

The belt cleaner **35** includes a cleaning brush and a cleaning blade that contact an outer circumferential surface of the intermediate transfer belt **30**. A waste toner conveyance tube extending from the belt cleaner **35** to an inlet of a waste toner container conveys waste toner collected from the intermediate transfer belt **30** by the belt cleaner **35** to the waste toner container.

A bottle holder **2** situated in an upper portion of the image forming apparatus **1** accommodates four toner bottles **2**Y, **2**M, **2**C, and **2**K detachably attached thereto to contain and supply fresh yellow, magenta, cyan, and black toners to the development devices **7** of the image forming devices **4**Y, **4**M, **4**C, and **4**K, respectively. For example, the fresh yellow, magenta, cyan, and black toners are supplied from the toner bottles **2**Y, **2**M, **2**C, and **2**K to the development devices **7** through toner supply tubes interposed between the toner bottles **2**Y, **2**M, **2**C, and **2**K and the development devices **7**, respectively.

In a lower portion of the image forming apparatus **1** are a paper tray **10** that loads a plurality of recording media P (e.g., sheets) and a feed roller **11** that picks up and feeds a recording medium P from the paper tray **10** toward the secondary transfer nip formed between the secondary transfer roller **36** and the intermediate transfer belt **30**. The recording media P may be thick paper, postcards, envelopes, plain paper, thin paper, coated paper, art paper, tracing paper, overhead projector (OHP) transparencies, and the like. Additionally, a bypass tray that loads thick paper, postcards, envelopes, OHP transparencies, and the like may be attached to the image forming apparatus **1**.

A conveyance path R extends from the feed roller **11** to an output roller pair **13** to convey the recording medium P picked up from the paper tray **10** onto an outside of the image forming apparatus **1** through the secondary transfer nip. The conveyance path R is provided with a registration roller pair **12** located below the secondary transfer nip formed between the secondary transfer roller **36** and the intermediate transfer belt **30**, that is, upstream from the secondary transfer nip in a recording medium conveyance direction A**1**. The registration roller pair **12** serving as a timing roller pair feeds the recording medium P conveyed from the feed roller **11** toward the secondary transfer nip.

The conveyance path R is further provided with a fixing device **20** located above the secondary transfer nip, that is, downstream from the secondary transfer nip in the recording medium conveyance direction A**1**. The fixing device **20** fixes a toner image transferred from the intermediate transfer belt **30** onto the recording medium P conveyed from the secondary transfer nip. The conveyance path R is further provided with the output roller pair **13** located above the fixing device **20**, that is, downstream from the fixing device **20** in the recording medium conveyance direction A**1**. The output roller pair **13** discharges the recording medium P bearing the fixed toner image onto the outside of the image forming apparatus **1**, that is, an output tray **14** disposed atop the image forming apparatus **1**. The output tray **14** stocks the recording medium P discharged by the output roller pair **13**.

With reference to FIG. **1**, a description is provided of an image forming operation of the image forming apparatus **1** having the structure described above to form a color toner image on a recording medium P.

As a print job starts, a driver drives and rotates the photoconductors **5** of the image forming devices **4**Y, **4**M, **4**C, and **4**K, respectively, clockwise in FIG. **1** in a rotation direction R**2**. The chargers **6** uniformly charge the outer circumferential surface of the respective photoconductors **5** at a predetermined polarity. The exposure device **9** emits laser beams onto the charged outer circumferential surface of the respective photoconductors **5** according to yellow, magenta, cyan, and black image data contained in image data sent from the external device, respectively, thus forming electrostatic latent images thereon. The development devices **7** supply yellow, magenta, cyan, and black toners to the electrostatic latent images formed on the photoconductors **5**, visualizing the electrostatic latent images into yellow, magenta, cyan, and black toner images, respectively.

Simultaneously, as the print job starts, the secondary transfer backup roller **32** is driven and rotated counterclockwise in FIG. **1**, rotating the intermediate transfer belt **30** in the rotation direction R**1** by friction therebetween. The power supply applies a constant voltage or a constant current control voltage having a polarity opposite a polarity of the toner to the primary transfer rollers **31**, creating a transfer electric field at each primary transfer nip formed between the photoconductor **5** and the primary transfer roller **31**.

When the yellow, magenta, cyan, and black toner images formed on the photoconductors **5** reach the primary transfer nips, respectively, in accordance with rotation of the photoconductors **5**, the yellow, magenta, cyan, and black toner images are primarily transferred from the photoconductors **5** onto the intermediate transfer belt **30** by the transfer electric field created at the primary transfer nips such that the yellow, magenta, cyan, and black toner images are superimposed successively on a same position on the intermediate transfer belt **30**. Thus, a color toner image is formed on the outer circumferential surface of the intermediate transfer belt **30**. After the primary transfer of the yellow, magenta, cyan, and black toner images from the photoconductors **5** onto the intermediate transfer belt **30**, the cleaners **8** remove residual toner failed to be transferred onto the intermediate transfer belt **30** and therefore remaining on the photoconductors **5** therefrom. Thereafter, dischargers discharge the outer circumferential surface of the respective photoconductors **5**, initializing the surface potential thereof.

On the other hand, the feed roller **11** disposed in the lower portion of the image forming apparatus **1** is driven and rotated to feed a recording medium P from the paper tray **10** toward the registration roller pair **12** in the conveyance path R. As the recording medium P comes into contact with the registration roller pair **12**, the registration roller pair **12** that interrupts its rotation temporarily halts the recording medium P.

Thereafter, the registration roller pair **12** resumes its rotation and conveys the recording medium P to the secondary transfer nip at a time when the color toner image formed on the intermediate transfer belt **30** reaches the secondary transfer nip. The secondary transfer roller **36** is applied with a transfer voltage having a polarity opposite a polarity of the charged yellow, magenta, cyan, and black toners constituting the color toner image formed on the intermediate transfer belt **30**, thus creating a transfer electric field at the secondary transfer nip. The transfer electric field secondarily transfers the yellow, magenta, cyan, and black toner images constituting the color toner image formed on the intermediate transfer belt **30** onto the recording medium P collectively. After the secondary transfer of the color toner image from the intermediate transfer belt **30** onto the recording medium P, the belt cleaner **35** removes residual toner failed to be transferred onto the recording medium P and therefore remaining on the intermediate transfer belt **30** therefrom. The removed toner is conveyed and collected into the waste toner container.

Thereafter, the recording medium P bearing the color toner image is conveyed to the fixing device **20** that fixes the color toner image on the recording medium P. Then, the recording medium P bearing the fixed color toner image is discharged by the output roller pair **13** onto the output tray **14**.

The above describes the image forming operation of the image forming apparatus **1** to form the color toner image on the recording medium P. Alternatively, the image forming apparatus **1** may form a monochrome toner image by using any one of the four image forming devices **4**Y, **4**M, **4**C, and **4**K or may form a bicolor or tricolor toner image by using two or three of the image forming devices **4**Y, **4**M, **4**C, and **4**K.

With reference to FIGS. **2** to **4**, a description is provided of a construction of the fixing device **20** incorporated in the image forming apparatus **1** described above.

FIG. **2** is a vertical sectional view of the fixing device **20** illustrating a heat shield **27** incorporated therein that is situated at a shield position. FIG. **3** is a vertical sectional view of the fixing device **20** illustrating the heat shield **27** situated at a retracted position. FIG. **4** is a block diagram of the image forming apparatus **1**.

As shown in FIG. **2**, the fixing device **20** (e.g., a fuser) includes a fixing belt **21** serving as a fixing rotary body or an endless belt formed into a loop and rotatable in a rotation direction R**3**; a pressing roller **22** serving as an opposed body disposed opposite an outer circumferential surface of the fixing belt **21** to separably contact the fixing belt **21** and rotatable in a rotation direction R**4** counter to the rotation direction R**3** of the fixing belt **21**; a halogen heater pair **23** serving as a heater disposed inside the loop formed by the fixing belt **21** and heating the fixing belt **21**; a nip formation assembly **24** disposed inside the loop formed by the fixing belt **21** and pressing against the pressing roller **22** via the fixing belt **21** to form a fixing nip N between the fixing belt **21** and the pressing roller **22**; a stay **25** serving as a support disposed inside the loop formed by the fixing belt **21** and contacting and supporting the nip formation assembly **24**; a reflector **26** disposed inside the loop formed by the fixing belt **21** and reflecting light radiated from the halogen heater pair **23** toward the fixing belt **21**; the heat shield **27** interposed between the halogen heater pair **23** and the fixing belt **21** to shield the fixing belt **21** from light radiated from the halogen heater pair **23**; a temperature sensor **28** serving as a primary temperature detector disposed opposite the outer circumferential surface of the fixing belt **21** and detecting the temperature of the fixing belt **21**; and a recording medium sensor **29** serving as a recording medium detector disposed downstream from the fixing nip N in the recording medium conveyance direction A**1** and detecting a recording medium P discharged from the fixing nip N.

The fixing belt **21** and the components disposed inside the loop formed by the fixing belt **21**, that is, the halogen heater pair **23**, the nip formation assembly **24**, the stay **25**, the reflector **26**, and the heat shield **27**, may constitute a belt unit **21**U separably coupled with the pressing roller **22**.

A detailed description is now given of a construction of the fixing belt **21**.

The fixing belt **21** is a thin, flexible endless belt or film. For example, the fixing belt **21** is constructed of a base layer constituting an inner circumferential surface of the fixing belt **21** and a release layer constituting the outer circumferential surface of the fixing belt **21**. The base layer is made of metal such as nickel and SUS stainless steel or resin such as polyimide (PI). The release layer is made of tetrafluoroethylene-perfluoroalkylvinylether copolymer (PFA), polytetrafluoroethylene (PTFE), or the like. Alternatively, an elastic layer made of rubber such as silicone rubber, silicone rubber foam, and fluoro rubber may be interposed between the base layer and the release layer.

If the fixing belt **21** does not incorporate the elastic layer, the fixing belt **21** has a decreased thermal capacity that improves fixing property of being heated to a predetermined fixing temperature quickly. However, as the pressing roller **22** and the fixing belt **21** sandwich and press a toner image T on a recording medium P passing through the fixing nip N, slight surface asperities of the fixing belt **21** may be transferred onto the toner image T on the recording medium P, resulting in variation in gloss of the solid toner image T. To address this problem, it is preferable that the fixing belt **21** incorporates the elastic layer having a thickness not smaller than about 100 micrometers. The elastic layer having the thickness not smaller than about 100 micrometers elastically deforms to absorb slight surface asperities of the fixing belt **21**, preventing variation in gloss of the toner image T on the recording medium P.

According to this exemplary embodiment, the fixing belt **21** is designed to be thin and have a reduced loop diameter so as to decrease the thermal capacity thereof. For example, the fixing belt **21** is constructed of the base layer having a thickness in a range of from about 20 micrometers to about 50 micrometers; the elastic layer having a thickness in a range of from about 100 micrometers to about 300 micrometers; and the release layer having a thickness in a range of from about 10 micrometers to about 50 micrometers. Thus, the fixing belt **21** has a total thickness not greater than about 1 mm. A loop diameter of the fixing belt **21** is in a range of from about 20 mm to about 40 mm. In order to decrease the thermal capacity of the fixing belt **21** further, the fixing belt **21** may have a total thickness not greater than about 0.20 mm and preferably not greater than about 0.16 mm. Additionally, the loop diameter of the fixing belt **21** may not be greater than about 30 mm.

A detailed description is now given of a construction of the pressing roller **22**.

The pressing roller **22** is constructed of a metal core **22***a*; an elastic layer **22***b* coating the metal core **22***a* and made of silicone rubber foam, silicone rubber, fluoro rubber, or the like; and a release layer **22***c* coating the elastic layer **22***b* and made of PFA, PTFE, or the like. A pressurization assembly described below presses the pressing roller **22** against the nip formation assembly **24** via the fixing belt **21**. Thus, the pressing roller **22** pressingly contacting the fixing belt **21** deforms the elastic layer **22***b* of the pressing roller **22** at the fixing nip N formed between the pressing roller **22** and the fixing belt **21**, thus creating the fixing nip N having a predetermined length in the recording medium conveyance direction A**1**. According to this exemplary embodiment, the pressing roller **22** is pressed against the fixing belt **21**. Alternatively, the pressing roller **22** may merely contact the fixing belt **21** with no pressure therebetween.

A fixing motor **92** depicted in FIG. **4** that is disposed inside the image forming apparatus **1** serves as a driver that drives and rotates the pressing roller **22**. As the fixing motor **92** drives and rotates the pressing roller **22**, a driving force of the fixing motor **92** is transmitted from the pressing roller **22** to the fixing belt **21** at the fixing nip N, thus rotating the fixing belt **21** by friction between the pressing roller **22** and the fixing belt **21**. Alternatively, the fixing motor **92** may also be connected to the fixing belt **21** to drive and rotate the fixing belt **21**.

According to this exemplary embodiment, the pressing roller **22** is a solid roller. Alternatively, the pressing roller **22** may be a hollow roller. In this case, a heater such as a halogen heater may be disposed inside the hollow roller. The elastic layer **22***b* may be made of solid rubber. Alternatively, if no heater is situated inside the pressing roller **22**, the elastic layer **22***b* may be made of sponge rubber. The sponge rubber is more preferable than the solid rubber because it has an increased insulation that draws less heat from the fixing belt **21**.

A detailed description is now given of a configuration of the halogen heater pair **23**.

The halogen heater pair **23** is situated inside the loop formed by the fixing belt **21** and upstream from the fixing nip N in the recording medium conveyance direction A**1**. For example, the halogen heater pair **23** is situated lower than and upstream from a hypothetical line L passing through a center Q of the fixing nip N in the recording medium conveyance direction A**1** and an axis O of the pressing roller **22** in FIG. **2**. The power supply situated inside the image forming apparatus **1** supplies power to the halogen heater pair **23** so that the halogen heater pair **23** heats the fixing belt **21**. As shown in FIG. **4**, a controller **90** (e.g., a processor), that is, a central processing unit (CPU) provided with a random-access memory (RAM) and a read-only memory (ROM), for example, operatively connected to the halogen heater pair **23** and the temperature sensor **28** controls the halogen heater pair **23** based on the temperature of the fixing belt **21** detected by the temperature sensor **28** so as to adjust the temperature of the fixing belt **21** to a desired fixing temperature. Alternatively, the controller **90** may be operatively connected to a temperature sensor disposed opposite the pressing roller **22** to detect the temperature of the pressing roller **22** so that the controller **90** predicts the temperature of the fixing belt **21** based on the temperature of the pressing roller **22** detected by the temperature sensor, thus controlling the halogen heater pair **23**.

According to this exemplary embodiment, two halogen heaters constituting the halogen heater pair **23** are situated inside the loop formed by the fixing belt **21**. Alternatively, one halogen heater or three or more halogen heaters may be situated inside the loop formed by the fixing belt **21** according to the sizes of the recording media P available in the image forming apparatus **1**. Alternatively, instead of the halogen heater pair **23**, an induction heater, a resistance heat generator, a carbon heater, or the like may be employed as a heater that heats the fixing belt **21**.

A detailed description is now given of a construction of the nip formation assembly **24**.

The nip formation assembly **24** includes a base pad **241** and a slide sheet **240** (e.g., a low-friction sheet) covering an outer surface of the base pad **241**. For example, the slide sheet **240** covers an opposed face of the base pad **241** disposed opposite the fixing belt **21**. A longitudinal direction of the base pad **241** is parallel to an axial direction of the fixing belt **21** or the pressing roller **22**. The base pad **241** receives pressure from the pressing roller **22** to define the shape of the fixing nip N. According to this exemplary embodiment, the fixing nip N is planar in cross-section as shown in FIG. **2**. Alternatively, the fixing nip N may be concave with respect to the pressing roller **22** or have other shapes. The slide sheet **240** reduces friction between the base pad **241** and the fixing belt **21** sliding thereover as the fixing belt **21** rotates in the rotation direction R**3**. Alternatively, the base pad **241** may be made of a low friction material. In this case, the slide sheet **240** is not interposed between the base pad **241** and the fixing belt **21**.

The base pad **241** is made of a heat resistant material resistant against temperatures of 200 degrees centigrade or higher to prevent thermal deformation of the nip formation assembly **24** by temperatures in a fixing temperature range desirable to fix the toner image T on the recording medium P, thus retaining the shape of the fixing nip N and quality of the toner image T formed on the recording medium P. The base pad **241** is also made of a rigid material having an increased mechanical strength. For example, the base pad **241** is made of resin such as polyether sulfone (PES), polyphenylene sulfide (PPS), liquid crystal polymer (LCP), polyether nitrile (PEN), polyamide imide (PAI), polyether ether ketone (PEEK), or the like. Alternatively, the base pad **241** may be made of metal, ceramic, or the like.

The base pad **241** is mounted on and supported by the stay **25**. Accordingly, even if the base pad **241** receives pressure from the pressing roller **22**, the base pad **241** is not bent by the pressure and therefore produces a uniform nip width throughout the entire width of the pressing roller **22** in the axial direction thereof. The stay **25** is made of metal having an increased mechanical strength, such as stainless steel and iron, to prevent bending of the nip formation assembly **24**.

A detailed description is now given of a construction of the reflector **26**.

The reflector **26** is mounted on and supported by the stay **25** and disposed opposite the halogen heater pair **23**. The reflector **26** reflects light or heat radiated from the halogen heater pair **23** thereto onto the fixing belt **21**, suppressing conduction of heat from the halogen heater pair **23** to the stay **25**. Thus, the reflector **26** facilitates efficient heating of the fixing belt **21**, saving energy. For example, the reflector **26** is made of aluminum, stainless steel, or the like. If the reflector **26** includes an aluminum base treated with silver-vapor-deposition to decrease radiation and increase reflectance of light, the reflector **26** facilitates heating of the fixing belt **21**.

A detailed description is now given of a configuration of the heat shield **27**.

The heat shield **27** is a metal plate, having a thickness in a range of from about 0.1 mm to about 1.0 mm, curved in a circumferential direction of the fixing belt **21** along the inner circumferential surface thereof. The heat shield **27** is interposed between the halogen heater pair **23** and the fixing belt **21** and movable in the circumferential direction of the fixing belt **21**. As shown in FIG. **3**, a circumference of the fixing belt **21** is divided into two sections: a circumferential, direct heating span α where the halogen heater pair **23** is disposed opposite and heats the fixing belt **21** directly and a circumferential, indirect heating span β where the halogen heater pair **23** is disposed opposite the fixing belt **21** indirectly via the components other than the heat shield **27** (e.g., the reflector **26**, the stay **25**, the nip formation assembly **24**, and the like) that are mounted on a pair of side plates of the fixing device **20**. The heat shield **27** moves to the shield position shown in FIG. **2** where the heat shield **27** is disposed opposite the halogen heater pair **23** directly in the direct heating span α to shield the fixing belt **21** from the halogen heater pair **23**. The shield position may be located at one or more positions within the direct heating span α. Conversely, the heat shield **27** moves to the retracted position shown in FIG. **3** where the heat shield **27** retracts from the direct heating span α to the indirect heating span β and therefore is disposed opposite the halogen heater pair **23** indirectly. That is, the heat shield **27** is entirely behind the reflector **26** and the stay **25** and therefore disposed opposite the halogen heater pair **23** via the reflector **26** and the stay **25**. Thus, the heat shield **27** does not shield the fixing belt **21** from the halogen heater pair **23**. As the heat shield **27** moves in the circumferential direction of the fixing belt **21**, the heat shield **27** changes the area of the direct heating span α on the fixing belt **21**, adjusting an amount of heat radiated from the halogen heater pair **23** to the fixing belt **21**. The heat shield **27** is made of a heat resistant material, for example, metal such as aluminum, iron, and stainless steel or ceramic.

A detailed description is now given of a configuration of the recording medium sensor **29**.

As shown in FIG. **2**, the recording medium sensor **29** is disposed downstream from the fixing nip N in a recording medium conveyance direction A2 to detect the recording medium P discharged from the fixing nip N. For example, the recording medium sensor **29** may be a photo interrupter.

With reference to FIG. **5**, a description is provided of a configuration of flanges **40** incorporated in the fixing device **20**.

FIG. **5** is a partial perspective view of the fixing device **20**. As shown in FIG. **5**, the flanges **40** serving as a belt holder are inserted into both lateral ends of the fixing belt **21** in the axial direction thereof, respectively, to rotatably support the fixing belt **21**. Both lateral ends of the flanges **40**, the halogen heater pair **23**, and the stay **25** in the axial direction of the fixing belt **21** are mounted on and supported by the pair of side plates of the fixing device **20**, respectively.

With reference to FIG. **6**, a description is provided of a construction of a support mechanism that supports the heat shield **27**.

FIG. **6** is a partial perspective view of the fixing device **20** illustrating one lateral end of the heat shield **27** in the axial direction of the fixing belt **21**. As shown in FIG. **6**, the heat shield **27** is supported by an arcuate slider **41** rotatably or slidably attached to the flange **40**. For example, a projection **27***a* disposed at each lateral end of the heat shield **27** in the axial direction of the fixing belt **21** is inserted into a hole **41***a* produced in the slider **41**. Thus, the heat shield **27** is attached to the slider **41**. The slider **41** includes a tab **41***b* projecting inboard in the axial direction of the fixing belt **21** toward the heat shield **27**. As the tab **41***b* of the slider **41** is inserted into an arcuate groove **40***a* produced in the flange **40**, the slider **41** is slidably movable in the groove **40***a*. Accordingly, the heat shield **27**, together with the slider **41**, is rotatable or movable in a circumferential direction of the flange **40**. The flange **40** and the slider **41** are made of resin.

Although FIG. **6** illustrates the support mechanism that supports the heat shield **27** at one lateral end thereof in the axial direction of the fixing belt **21**, another lateral end of the heat shield **27** in the axial direction of the fixing belt **21** is also supported by the support mechanism shown in FIG. **6**. Thus, another lateral end of the heat shield **27** is also rotatably or movably supported by the slider **41** slidable in the groove **40***a* of the flange **40**.

With reference to FIG. **7**, a description is provided of a construction of a heat shield driver **46** that drives and rotates the heat shield **27**.

FIG. **7** is a partial perspective view of the fixing device **20** illustrating the heat shield driver **46**. As shown in FIG. **7**, the heat shield driver **46** includes a motor **42** serving as a driving source and a plurality of gears **43**, **44**, and **45** constituting a gear train. The gear **43** serving as one end of the gear train is connected to the motor **42**. The gear **45** serving as another end of the gear train is connected to a gear **41***c* produced on the slider **41** along a circumferential direction thereof. Accordingly, as the motor **42** is driven, a driving force is transmitted from the motor **42** to the gear **41***c* of the slider **41** through the gear train, that is, the gears **43** to **45**, thus rotating the heat shield **27** supported by the slider **41** forward in a first rotation direction from the indirect heating span β to the direct heating span α and backward in a second rotation direction from the direct heating span α to the indirect heating span β. For example, the motor **42** is a stepping motor. In this case, the position of the heat shield **27** is adjusted by changing the number of driving pulses. Instead of the stepping motor, the motor **42** may be a direct current (DC) motor or the like.

With reference to FIG. **8**, a description is provided of a relation between the shape of the heat shield **27**, heat generators of the halogen heater pair **23**, and the sizes of recording media.

FIG. **8** is a schematic diagram of the fixing device **20** illustrating the halogen heater pair **23**, the heat shield **27**, and recording media of various sizes.

First, a detailed description is given of the shape of the heat shield **27**.

As shown in FIG. **8**, the heat shield **27** includes a pair of shield portions **48**, constituting both lateral ends of the heat shield **27** in an axial direction, that is, the longitudinal direction, thereof; a bridge **49** bridging the shield portions **48** in the axial direction of the heat shield **27**; and a recess **50** defined by the shield portions **48** and the bridge **49**, and in turn itself defining an inboard edge of each shield portion **48**. The shield portions **48** are disposed opposite both lateral ends of the halogen heater pair **23** in the axial direction of the fixing belt **21**, respectively, to shield both lateral ends of the fixing belt **21** in the axial direction thereof from the halogen heater pair **23**. The recess **50** between the pair of shield portions **48** in the axial direction of the heat shield **27** does not shield the fixing belt **21** from the halogen heater pair **23** and therefore allows light radiated from the halogen heater pair **23** to irradiate the fixing belt **21**.

The inboard edge of each shield portion **48** includes a circumferentially straight edge **51** extending parallel to the circumferential direction of the heat shield **27** in which the heat shield **27** pivots and a sloped edge **52** angled relative to the circumferentially straight edge **51**. As shown in FIG. **8**, the sloped edge **52** is contiguous to the circumferentially straight edge **51** substantially in a shield direction Y in which the heat shield **27** moves from the retracted position shown in FIG. **3** to the shield position shown in FIG. **2**. The sloped edge **52** is angled outboard from the circumferentially straight edge **51** substantially in the shield direction Y such that an interval between the sloped edge **52** and another sloped edge **52** increases. Accordingly, the recess **50** has a uniform, decreased width defined by the circumferentially straight edges **51** in the axial direction of the heat shield **27** and an increased width defined by the sloped edges **52** in the axial direction of the heat shield **27** that increases gradually in the shield direction Y.

Next, a detailed description is given of a relation between the heat generators of the halogen heater pair **23** and the sizes of the recording media.

As shown in FIG. **8**, the halogen heater pair **23** has a plurality of heat generators having different lengths in the axial direction of the fixing belt **21** and being situated at different positions in the axial direction of the fixing belt **21** to heat different axial spans on the fixing belt **21** according to the size of the recording medium P. For example, the halogen heater pair **23** is constructed of the lower halogen heater **23** having a center heat generator **23***a* disposed opposite a center of the fixing belt **21** in the axial direction thereof and the upper halogen heater **23** having lateral end heat generators **23***b* disposed opposite both lateral ends of the fixing belt **21** in the axial direction thereof, respectively. The center heat generator **23***a* spans a conveyance span S**2** corresponding to a width W**2** of a medium recording medium P**2** in the axial direction of the fixing belt **21**. Conversely, the lateral end heat generators **23***b*, together with the center heat generator **23***a*, span α conveyance span S**3** corresponding to a width W**3** of a large recording medium P**3** greater than the width W**2** of the medium recording medium P**2** and a conveyance span S**4** corresponding to a width W**4** of an extra-large recording medium P**4** greater than the width W**3** of the large recording medium P**3**.

A detailed description is now given of a relation between the shape of the heat shield **27** and the sizes of the recording media P**2**, P**3**, and P**4**.

Each circumferentially straight edge **51** is situated inboard from and in proximity to an edge of the conveyance span S**3** corresponding to the width W**3** of the large recording medium P**3** in the axial direction of the fixing belt **21**. Each sloped edge **52** overlaps the edge of the conveyance span S**3**.

For example, the medium recording medium P**2** is a letter size recording medium having a width W**2** of 215.9 mm or an A4 size recording medium having a width W**2** of 210 mm. The large recording medium P**3** is a double letter size recording medium having a width W**3** of 279.4 mm or an A3 size recording medium having a width W**3** of 297 mm. The extra-large recording medium P**4** is an A3 extension size recording medium having a width W**4** of 329 mm. However, the medium recording medium P**2**, the large recording medium P**3**, and the extra-large recording medium P**4** may include recording media of other sizes. Additionally, the medium, large, and extra-large sizes mentioned herein are relative terms. Hence, instead of the medium, large, and extra-large sizes, small, medium, and large sizes may be used.

With reference to FIGS. **8** and **9**, a description is provided of control of the halogen heater pair **23** and the heat shield **27** according to the sizes of recording media.

FIG. **9** is a partial schematic diagram of the fixing device **20**. As the medium recording medium P**2** is conveyed over the fixing belt **21** depicted in FIG. **2**, the controller **90** depicted in FIG. **4** turns on the center heat generator **23***a* to heat the conveyance span S**2** of the fixing belt **21** corresponding to the width W**2** of the medium recording medium P**2**. As the extra-large recording medium P**4** is conveyed over the fixing belt **21**, the controller **90** turns on the lateral end heat generators **23***b* as well as the center heat generator **28***a* to heat the conveyance span S**4** of the fixing belt **21** corresponding to the width W**4** of the extra-large recording medium P**4**.

However, the halogen heater pair **23** is configured to heat the conveyance span S**2** corresponding to the width W**2** of the medium recording medium P**2** and the conveyance span S**4** corresponding to the width W**4** of the extra-large recording medium P**4**. Accordingly, if the center heat generator **23***a* is turned on as the large recording medium P**3** is conveyed over the fixing belt **21**, the center heat generator **23***a* does not heat each outboard span S**2***a* outboard from the conveyance span S**2** in the axial direction of the fixing belt **21**. Consequently, the large recording medium P**3** is not heated throughout the entire width W**3** thereof. Conversely, if the lateral end heat generators **23***b* and the center heat generator **23***a* are turned on, the lateral end heat generators **23***b* may heat both outboard spans S**3***a* outboard from the conveyance span S**3** in the axial direction of the fixing belt **21** corresponding to the width W**3** of the large recording medium P**3**. If the large recording medium P**3** is conveyed over the fixing belt **21** while the lateral end heat generators **23***b* and the center heat generator **23***a* are turned on, the lateral end heat generators **23***b* may heat both outboard spans S**3***a* outboard from the conveyance span S**3** in the axial direction of the fixing belt **21** corresponding to the width W**3** of the large recording medium P**3**, resulting in overheating of the fixing belt **21** in the outboard spans S**3***a*.

To address this circumstance, as the large recording medium P**3** is conveyed over the fixing belt **21**, the heat shield **27** moves to the shield position as shown in FIG. **9**. At the shield position shown in FIG. **9**, the shield portions **48** of the heat shield **27** shield the fixing belt **21** in a span in proximity to both side edges of the large recording medium P**3** and the outboard spans S**3***a*, thus suppressing overheating of the fixing belt **21** in the outboard spans S**3***a* where the large recording medium P**3** is not conveyed. Thus, the fixing device **20** performs a fixing job precisely by moving the heat shield **27** to the shield position shown in FIG. **2** at a proper time without decreasing the rotation speed of the fixing belt **21** and the pressing roller **22** to convey the large recording medium P**3**.

When the fixing job is finished or the temperature of the outboard spans S**3***a* of the fixing belt **21** where the large recording medium P**3** is not conveyed decreases to a predetermined threshold and therefore the heat shield **27** is no longer requested to shield the fixing belt **21**, the controller **90** moves the heat shield **27** to the retracted position shown in FIG. **3** where the heat shield **27** is disposed opposite the indirect heating span β on the fixing belt **21**.

Since each shield portion **48** includes the sloped edge **52** as shown in FIG. **8**, as the rotation angle of the heat shield **27** changes, the shield portions **48** shield the fixing belt **21** from the lateral end heat generators **23***b* in a variable area. For example, if the number of recording media conveyed through the fixing nip N and a conveyance time for which the recording media are conveyed through the fixing nip N increase, the fixing belt **21** is subject to overheating in a non-conveyance span (e.g., the outboard spans S**2***a* and S**3***a*) thereof. To address this circumstance, when the number of recording media conveyed through the fixing nip N reaches a predetermined number or when the conveyance time reaches a predetermined conveyance time, the controller **90** moves the heat shield **27** in the shield direction Y to the shield position shown in FIG. **2** where the shield portions **48** are disposed opposite the lateral end heat generators **23***b*, respectively, suppressing overheating of the fixing belt **21** precisely.

The temperature sensor **28** for detecting the temperature of the fixing belt **21** is disposed opposite an axial span on the fixing belt **21** where the fixing belt **21** is subject to overheating. According to this exemplary embodiment, as shown in FIG. **8**, the temperature sensor **28** is disposed opposite each outboard span S**3***a* outboard from the conveyance span S**3** corresponding to the width W**3** of the large recording medium P**3** because the fixing belt **21** is subject to overheating in the outboard span S**3***a*. Since the fixing belt **21** is subject to overheating by light radiated from the lateral end heat generators **23***b*, the temperature sensors **28** are disposed opposite the lateral end heat generators **23***b*, respectively. Although FIG. **8** illustrates the two temperature sensors **28** disposed opposite the conveyance span S**4** corresponding to the width W**4** of the extra-large recording medium P**4**, one of the two temperature sensors **28** may be eliminated. Alternatively, the temperature sensor **28** may be located at other positions, for example, the temperature sensor **28** may be disposed opposite a center of the fixing belt **21** in the axial direction thereof. The number of the temperature sensors **28** may be changed arbitrarily. For example, three or more temperature sensors **28** may be aligned in the axial direction of the fixing belt **21**.

With reference to FIGS. **10** and **11**, a description is provided of a configuration of a fixing device **20**S incorporating a heat shield **27**S according to another exemplary embodiment.

FIG. **10** is a schematic diagram of the fixing device **20**S. FIG. **11** is a partial schematic diagram of the fixing device **20**S. As shown in FIG. **10**, the heat shield **27**S includes a pair of shield portions **48**S disposed at both lateral ends of the heat shield **27**S in an axial direction thereof, respectively. Each of the shield portions **48**S has two steps. For example, each shield portion **48**S includes an outboard, small shield section **48***a* having a decreased length in a longitudinal direction of the heat shield **27**S parallel to the axial direction thereof and an inboard, great shield section **48***b* having an increased length in the longitudinal direction of the heat shield **27**S. The bridge **49** bridges the great shield section **48***b* of one shield portion **48**S serving as a primary shield portion situated at one lateral end of the heat shield **27**S and the great shield section **48***b* of another shield portion **48**S serving as a secondary shield portion situated at another lateral end of the heat shield **27**S in the axial direction thereof. The small shield section **48***a* is contiguous to the great shield section **48***b* substantially in the shield direction Y.

A sloped edge **52***a*, that is, an inboard edge of the small shield section **48***a* in the axial direction of the heat shield **27**S, is disposed opposite another sloped edge **52***a*, that is, an inboard edge of another small shield section **48***a* in the axial direction of the heat shield **27**S. Similarly, a sloped edge **52***b*, that is, an inboard edge of the great shield section **48***b* in the axial direction of the heat shield **27**S, is disposed opposite another sloped edge **52***b*, that is, an inboard edge of another great shield section **48***b* in the axial direction of the heat shield **27**S. The two sloped edges **52***b* of the great shield sections **48***b* are angled relative to the bridge **49** such that an interval between the two sloped edges **52***b* in the axial direction of the heat shield **27**S increases gradually in the shield direction Y. Similarly, the two sloped edges **52***a* of the small shield sections **48***a* are angled relative to the bridge **49** such that an interval between the two sloped edges **52***a* in the axial direction of the heat shield **27**S increases gradually in the shield direction Y. Unlike the heat shield **27** depicted in FIG. **8**, the heat shield **27**S does not incorporate the circumferentially straight edges **51**.

At least four sizes of recording media P, including a small recording medium P**1**, a medium recording medium P**2**, a large recording medium P**3**, and an extra-large recording medium P**4**, are available in the fixing device **20**S. For example, the small recording medium P**1** includes a postcard having a width of 100 mm. The medium recording medium P**2** includes an A4 size recording medium having a width of 210 mm. The large recording medium P**3** includes an A3 size recording medium having a width of 297 mm. The extra-large recording medium P**4** includes an A3 extension size recording medium having a width of 329 mm. However, the small recording medium P**1**, the medium recording medium P**2**, the large recording medium P**3**, and the extra-large recording medium P**4** may include recording media of other sizes.

A width W**1** of the small recording medium P**1** is smaller than the length of the center heat generator **23***a* in a longitudinal direction of the halogen heater pair **23** parallel to the axial direction of the heat shield **27**S. The sloped edge **52***b* of the great shield section **48***b* overlaps a side edge of the small recording medium P**1**. The sloped edge **52***a* of the small shield section **48***a* overlaps a side edge of the large recording medium P**3**. It is to be noted that a description of the relation between the position of recording media other than the small recording medium P**1**, that is, the medium recording medium P**2**, the large recording medium P**3**, and the extra-large recording medium P**4**, and the position of the center heat generator **23***a* and the lateral end heat generators **23***b* of the fixing device **20**S is omitted because it is similar to that of the fixing device **20** described above.

As the small recording medium P**1** is conveyed through the fixing nip N, the center heat generator **23***a* is turned on. However, since the center heat generator **23***a* heats the conveyance span S**2** on the fixing belt **21** corresponding to the width W**2** of the medium recording medium P**2** that is greater than the width W**1** of the small recording medium P**1**, the controller **90** moves the heat shield **27**S to the shield position shown in FIG. **11**. At the shield position shown in FIG. **11**, each great shield section **48***b* of the heat shield **27**S shields the fixing belt **21** from the center heat generator **23***a* in an outboard span S**1***a* outboard from a conveyance span S**1** corresponding to the width W**1** of the small recording medium P**1** in the axial direction of the fixing belt **21**. Accordingly, the fixing belt **21** does not overheat in each outboard span S**1***a* where the small recording medium P**1** is not conveyed over the fixing belt **21**.

As the medium recording medium P**2**, the large recording medium P**3**, and the extra-large recording medium P**4** are conveyed through the fixing nip N, the controller **90** performs a control for controlling the halogen heater pair **23** and the heat shield **27**S that is similar to the control for controlling the halogen heater pair **23** and the heat shield **27** described above. In this case, each small shield section **48***a* of the heat shield **27**S shields the fixing belt **21** from the halogen heater pair **23** as each shield portion **48** of the fixing device **20** does.

Like the shield portion **48** of the fixing device **20** that has the sloped edge **52**, the small shield section **48***a* and the great shield section **48***b* have the sloped edges **52***a* and **52***b*, respectively. Accordingly, by changing the rotation angled position of the heat shield **27**S, the controller **90** changes the span on the fixing belt **21** shielded from the center heat generator **23***a* and the lateral end heat generators **23***b* of the halogen heater pair **23** by the small shield section **48***a* and the great shield section **48***b* of each shield portion **48**S.

With reference to FIGS. **12**A and **12**B, a description is provided of a construction of a pressurization assembly **60** incorporated in the fixing devices **20** and **20**S described above.

FIG. **12**A is a vertical sectional view of the fixing device **20** illustrating the pressurization assembly **60** separating the pressing roller **22** from the fixing belt **21**. FIG. **12**B is a vertical sectional view of the fixing device **20** illustrating the pressurization assembly **60** pressing the pressing roller **22** against the fixing belt **21**. As shown in FIG. **12**B, the pressurization assembly **60** presses the pressing roller **22** against the fixing belt **21** to form the fixing nip N between the pressing roller **22** and the fixing belt **21**. Conversely, as shown in FIG. **12**A, the pressurization assembly **60** releases pressure between the pressing roller **22** and the fixing belt **21**. For example, the pressurization assembly **60** separates the pressing roller **22** from the fixing belt **21** or brings the pressing roller **22** into contact with the fixing belt **21** with no pressure therebetween.

The pressurization assembly **60** includes a mechanism for detecting whether or not the pressing roller **20** presses against the fixing belt **21** at the fixing nip N. For example, the pressurization assembly **60** includes a lever **61**, a cam **62**, a biasing member **63** (e.g., a tension spring), a feeler **64** serving as a detected member, and a sensor **65** serving as a detector. The lever **61** is pivotably mounted on a shaft O1 at one end of the lever **61** in a longitudinal direction thereof. Another end of the lever **61** in the longitudinal direction thereof contacts an outer circumferential surface of the cam **62**. An intermediate portion of the lever **61** in the longitudinal direction thereof contacts the metal core **22***a* of the pressing roller **22** that projects outboard from the elastic layer **22***b* and the release layer **22***c* depicted in FIG. **2** at a lateral end of the pressing roller **22** in the axial direction thereof. The cam **62** is pivotably supported by an eccentric shaft O2 and is driven and rotated by a driver (e.g., a motor). The lever **61** is pressed against the outer circumferential surface of the cam **62** by resilience from the biasing member **63**.

The pressing roller **22** is supported by the side plates of the fixing device **20** such that the pressing roller **22** is slidable horizontally in FIGS. **12**A and **12**B to press against the fixing belt **21** and release pressure between the fixing belt **21** and the pressing roller **22**. As shown in FIG. **12**A, as the outer circumferential surface of a semicircle having a decreased diameter of the cam **62** contacts the lever **61**, the resilience generated by the biasing member **63** biases the lever **61** in a direction to separate from the metal core **22***a* of the pressing roller **22**. Accordingly, the pressing roller **22** moves in a direction to separate from the fixing belt **21**, thus exerting no pressure to the fixing belt **21**. Conversely, as shown in FIG. **12**B, as the outer circumferential surface of another semicircle having an increased diameter of the cam **62** contacts the lever **61**, the cam **62** presses the lever **61** against the metal core **22***a* of the pressing roller **22**, thus pressing the pressing roller **22** against the fixing belt **21** at the fixing nip N.

The feeler **64** is substantially formed in a semicircle pivotable about the shaft O2 in accordance with rotation of the cam **62**. As shown in FIG. **12**A, as the pressing roller **22** contacts the fixing belt **21** with no pressure therebetween or is isolated from the fixing belt **21**, the feeler **64** overlaps the sensor **65** to shield the sensor **65** from light. The sensor **65** is a photo interrupter, for example. As the feeler **64** enters a gap between a light emitter and a light receiver of the sensor **65** to shield the light receiver from light emitted from the light emitter, the sensor **65** outputs a high signal to the controller **90** depicted in FIG. **4** that is operatively connected to the sensor **65**. Conversely, as the feeler **64** exits from the gap between the light emitter and the light receiver of the sensor **65** to allow the light emitted from the light emitter to reach the light receiver, the sensor **65** outputs a low signal to the controller **90**. Accordingly, as the sensor **65** outputs the high signal, the controller **90** determines that the pressing roller **22** contacts the fixing belt **21** with no pressure therebetween or is isolated from the fixing belt **21**. Conversely, as the sensor **65** outputs the low signal, the controller **90** determines that the pressing roller **22** presses against the fixing belt **21**.

As described above, the heat shields **27** and **27**S move to the various rotation angled positions according to the size of the recording medium P. To address this circumstance, the fixing devices **20** and **20**S include a position detector **53** that detects the rotation angled position of the heat shields **27** and **27**S as shown in FIGS. **13**A, **13**B, and **13**C.

With reference to FIGS. **13**A, **13**B, and **13**C, a description is provided of a configuration of the position detector **53** incorporated in the fixing device **20**.

FIG. **13**A is a vertical sectional view of the fixing device **20** illustrating the position detector **53** situated at a home position. FIG. **13**B is a vertical sectional view of the fixing device **20** illustrating the position detector **53** situated at a reference position. FIG. **13**C is a vertical sectional view of the fixing device **20** illustrating the position detector **53** situated at the shield position.

The position detector **53** detects the rotation angled position of the heat shield **27**. For example, the position detector **53** includes a single feeler **54** serving as a detected member and two sensors that detect the feeler **54**, that is, a home position sensor **55** and an angle sensor **56**. The feeler **54** is substantially formed in a fan or a triangle pivotable forward in a first pivot direction X1 and backward in a second pivot direction X2 in accordance with movement of the heat shield **27** through a linkage. The home position sensor **55** and the angle sensor **56** are mounted on a frame of the fixing device **20** such that the home position sensor **55** is isolated from the angle sensor **56** in the second pivot direction X2 of the feeler **54**. Each of the home position sensor **55** and the angle sensor **56** is a photo interrupter constructed of a light emitter and a light receiver, for example.

The home position sensor **55** situated upstream from the angle sensor **56** in the rotation direction R3 of the fixing belt **21** serves as a home position detector that detects a home position of the heat shield **27**. The angle sensor **56** serves as a rotation angle controller that controls the rotation angle of the heat shield **27**. When the heat shield **27** is at the home position shown in FIG. **13**A, an upstream edge **54***a* of the feeler **54** in the rotation direction R3 of the fixing belt **21**, that is, a leading edge of the feeler **54** in the backward, second pivot direction X2 of the feeler **54**, enters a gap between the light emitter and the light receiver of the home position sensor **55**. Thus, the upstream edge **54***a* of the feeler **54** shields the light receiver of the home position sensor **55** from light emitted from the light emitter of the home position sensor **55**. The angle sensor **56** is positioned relative to the home position sensor **55** such that a phase angle formed by the angle sensor **56** with the home position sensor **55** in the second pivot direction X2 of the feeler **54** is greater than a central angle A**54** of the feeler **54**.

As the heat shield **27** is at the home position shown in FIG. **13**A, the heat shield **27** does not shield the fixing belt **21** from the halogen heater pair **23** and allows the halogen heater pair **23** to heat the fixing belt **21** in the increased direct heating span α as shown in FIG. **3**. Further, as the heat shield **27** is at the home position shown in FIG. **13**A, the heat shield **27** is at an upstream end of the movable span thereof in the rotation direction R3 of the fixing belt **21**. Hence, during a print job, the heat shield **27** does not move beyond the home position shown in FIG. **13**A in the backward second pivot direction X2.

With the configuration of the position detector **53** described above, as the signal output by the home position sensor **55** switches from low to high, the controller **90** determines that the heat shield **27** is at the home position. Simultaneously, the angle sensor **56** outputs a low signal.

Conversely, as the heat shield **27** moves from the home position shown in FIG. **13**A in the forward first pivot direction X1 of the feeler **54**, that is, the rotation direction R3 of the fixing belt **21**, a downstream edge **54***b* of the feeler **54** in the rotation direction R3 of the fixing belt **21** overlaps the angle sensor **56** as shown in FIG. **13**B, shielding the light receiver of the angle sensor **56** from light emitted from the light emitter of the angle sensor **56**. Accordingly, the signal output by the angle sensor **56** switches from low to high. The position of the heat shield **27** shown in FIG. **13**B defines the reference position, that is, a zero point. As the motor **42** depicted in FIG. **7** rotates forward for a predetermined number of pulses, the heat shield **27** moves from the reference position shown in FIG. **13**B to a target shield position shown in FIG. **13**C. The reference position of the heat shield **27** is downstream from the home position thereof in the forward first pivot direction X**1**, that is, the rotation direction R**3** of the fixing belt **21**. Additionally, the home position of the heat shield **27** is set to a position where, as the heat shield **27** moves between the home position and the reference position in the forward first pivot direction X**1** and the backward second pivot direction X**2**, the position detector **53** detects that the heat shield **27** reaches the reference position and the home position.

In order to change the area of the direct heating span α of the fixing belt **21**, a terminal of the heat shield **27** movable in the circumferential direction of the fixing belt **21** is determined based on the distance or the rotation angle from the reference position of the heat shield **27** by open loop control. Accordingly, open loop control simplifies the structure of the position detector **53** compared to closed loop control in which the controller **90** drives and rotates the motor **42** based on feedback of the position of the heat shield **27** and halts the heat shield **27** after the controller **90** determines that the heat shield **27** reaches the shield position.

As the heat shield **27** pivots in the forward first pivot direction X**1** farther, the area of the fixing belt **21** shielded by the heat shield **27** from the halogen heater pair **23** increases in the direct heating span α. That is, as the heat shield **27** pivots in the forward first pivot direction X**1** farther, the area of the direct heating span α of the fixing belt **21** decreases. While the heat shield **27** moves between the home position shown in FIG. **13**A and the reference position shown in FIG. **13**B, the area of the fixing belt **21** shielded by the heat shield **27** from the halogen heater pair **23** in the direct heating span α is substantially zero. As the heat shield **27** moves from the reference position shown in FIG. **13**B in the forward first pivot direction X**1**, the area of the direct heating span α of the fixing belt **21** decreases. As the heat shield **27** pivoting in the forward first pivot direction X**1** halts at various shield positions, the area of the direct heating span α of the fixing belt **21** decreases stepwise.

A description is provided of an operation of the fixing device **20** before and during a print job.

As the controller **90** installable in the image forming apparatus **1** or the fixing device **20** receives a signal to start a print job, the controller **90** determines whether or not the heat shield **27** is at the home position shown in FIG. **13**A. For example, as described above, when the home position sensor **55** outputs a high signal as the feeler **54** shields the light receiver of the home position sensor **55** from light emitted from the light emitter of the home position sensor **55** and the angle sensor **56** outputs a low signal as the angle sensor **56** allows light emitted from the light emitter of the angle sensor **56** to reach the light receiver of the angle sensor **56**, the controller **90** determines that the heat shield **27** is at the home position. On the other hand, the pressurization assembly **60** situated at a depressurization position shown in FIG. **12**A where the pressurization assembly **60** brings the pressing roller **22** into contact with the fixing belt **21** with no pressure therebetween moves to a pressurization position shown in FIG. **12**B where the pressurization assembly **60** presses the pressing roller **22** against the fixing belt **21**. Thereafter, the controller **90** turns on the halogen heater pair **23**, causing the halogen heater pair **23** to start heating the fixing belt **21**.

After the halogen heater pair **23** is turned on, the heat shield **27** moves from the home position shown in FIG. **13**A in the forward first pivot direction X**1**. As the angle sensor **56** detects the feeler **54** at the reference position shown in FIG. **13**B, the controller **90** drives the motor **42** for the number of pulses corresponding to the distance from the reference position to the target shield position, moving the heat shield **27** to the target shield position shown in FIG. **13**C. Thereafter, as shown in FIG. **2**, a recording medium P bearing an unfixed toner image T is conveyed to the fixing nip N in the recording medium conveyance direction A**1** such that the unfixed toner image T faces the fixing belt **21**. As the fixing belt **21** rotating in the rotation direction R**3** and the pressing roller **22** rotating in the rotation direction R**4** convey the recording medium P bearing the toner image T through the fixing nip N, the fixing belt **21** and the pressing roller **22** apply heat and pressure to the recording medium P, fixing the toner image T on the recording medium P. Thus, the print job is finished.

The recording medium P bearing the fixed toner image T is discharged from the fixing nip N in the recording medium conveyance direction A**2**. As a leading edge of the recording medium P comes into contact with a front edge of a separator, the separator separates the recording medium P from the fixing belt **21**. Thereafter, the separated recording medium P is discharged by the output roller pair **13** depicted in FIG. **1** onto the outside of the image forming apparatus **1**, that is, the output tray **14** where the recording medium P is stocked.

With reference to FIG. **14**, a description is provided of an operation of the fixing device **20** after the print job is finished.

FIG. **14** is a timing chart illustrating operation of the components of the fixing device **20**. When the controller **90** depicted in FIG. **4** determines that a trailing edge of the last recording medium P of the print job is discharged from the fixing nip N, the controller **90** sends a stop signal to the fixing device **20**. Upon receipt of the stop signal, the controller **90** turns off the halogen heater pair **23** and then a heater relay. Next, the controller **90** causes the heat shield driver **46** to move and return the heat shield **27** to the home position shown in FIG. **13**A. When a preset time t**1** elapses after the heat shield **27** returns to the home position shown in FIG. **13**A, the controller **90** stops the fixing motor **92** depicted in FIG. **4** for driving and rotating the pressing roller **22**, thus halting the pressing roller **22** and the fixing belt **21**. Thereafter, the pressurization assembly **60** brings the pressing roller **22** into contact with the fixing belt **21** with no pressure therebetween as shown in FIG. **12**A.

The fixing belt **21** continues rotating for the preset time t**1** after the heat shield **27** returns to the home position shown in FIG. **13**A to prevent the fixing belt **21** from being heated locally by residual heat which may result in temperature variation of the fixing belt **21**. The preset time t**1** is determined by considering a time taken to even the temperature of the fixing belt **21**. For example, end of the preset time t**1** is determined based on the temperature of the fixing belt **21** detected by the temperature sensor **28** depicted in FIG. **2** or end of a predetermined time defines end of the preset time t**1**.

The above describes the operation of the fixing device **20** when the print job is completed safely. However, during the print job starting from receipt of the signal to start the print job until the recording medium P bearing the fixed toner image T is discharged onto the output tray **14** depicted in FIG. **1**, a fault may occur. For example, the recording medium P may be accidentally jammed in the conveyance path R or the image forming apparatus **1** may stop urgently due to malfunction of the components incorporated in the image forming apparatus **1**. If the controller **90** returns the heat shield **27** to the home position as it does when the print job is completed safely, even if the fault occurs, the controller **90** may stop the fixing device **20** with delay. Accordingly, the fixing belt **21** may be heated by residual heat, causing temperature variation or uneven temperatures of the fixing belt **21** which may result in deformation of the fixing belt **21**.

FIG. **15** is a partial vertical sectional view of the fixing device **20** illustrating deformation of the fixing belt **21**. As shown in FIG. **15**, the fixing belt **21** may deform in a deformation region Q**1** due to temperature variation. If the recording medium P is jammed inside the fixing device **20**, the jammed recording medium P may press the fixing belt **21** against an interior of the fixing belt **21**. If the controller **90** moves and returns the heat shield **27** to the home position shown in FIG. **13**A under such circumstance, since the heat shield **27** is configured to move in proximity to the inner circumferential surface of the fixing belt **21**, the inner circumferential surface of the deformed fixing belt **21** may slide over the heat shield **27** while damaging each other or the motor **42** depicted in FIG. **7** may suffer from malfunction due to overload.

To address this circumstance, if a fault occurs during a print job, the controller **90** controls the heat shield driver **46** to halt the heat shield **27** instantly to retain the heat shield **27** at a position where the heat shield **27** is situated at the time of the fault, not to move the heat shield **27** to other positions. Accordingly, even if the fixing belt **21** deforms as the fault occurs, the controller **91** prevents the deformed fixing belt **21** from sliding over the heat shield **27**, reducing damage to the fixing belt **21**, the heat shield **27**, and the heat shield driver **46** that drives the heat shield **27**.

Operation of the fixing device **20** when the fault occurs varies depending on whether or not the recording medium sensor **29** depicted in FIG. **2** detects the recording medium P.

With reference to FIG. **16**, a description is provided of an operation of the fixing device **20** if the recording medium sensor **29** detects the recording medium P when the fault occurs.

FIG. **16** is a timing chart illustrating operation of the components of the fixing device **20** when the recording medium sensor **29** detects the recording medium P. Upon receipt of a fault detection signal indicating a fault occurring in the image forming apparatus **1**, the controller **90** turns off the halogen heater pair **23** and then the heater relay. After the heater relay is turned off, the controller **90** controls the heat shield driver **46** to decrease the linear velocity of the fixing belt **21** rotating in the rotation direction R**3** to convey the recording medium P to a decreased linear velocity, thus rotating the fixing belt **21** forward in the rotation direction R**3** at the decreased linear velocity for a preset forward rotation time Ta. After the preset time Ta elapses, the controller **90** halts the fixing belt **21**. Thereafter, the pressurization assembly **60** that has pressed the pressing roller **22** against the fixing belt **21** releases pressure between the pressing roller **22** and the fixing belt **21**. Upon completion of the processes described above, an alarm **91** depicted in FIG. **4** that is provided in the image forming apparatus **1** issues an alarm that alarms a user about the fault occurring in the image forming apparatus **1**. For example, the alarm **91** is a notice that appears on a control panel disposed atop the image forming apparatus **1**, an alarm lamp turned on as the fault occurs, an alarm or an audible alarm, or the like. After the alarm **91** alarms the user about the fault, the controller **90** prohibits the user from using the fixing device **20**. During a series of processes described above, the heat shield **27** is retained at the position where the heat shield **27** is situated when the fault occurs.

When the recording medium sensor **29** detects the recording medium P, a leading edge of the recording medium P is discharged from the fixing nip N and separated from the fixing belt **21**. Accordingly, even if the fixing belt **21** rotates forward further in the rotation direction R**3** to convey the recording medium P in the recording medium conveyance direction A**2** depicted in FIG. **2**, the recording medium P is not wound around the fixing belt **21**. Hence, the processes described above select a stable operation to rotate the fixing belt **21** forward in the rotation direction R**3** after the halogen heater pair **23** is turned off.

While the fixing belt **21** rotates forward in the rotation direction R**3** after the halogen heater pair **23** is turned off, an unshielded region on the direct heating span α of the fixing belt **21** which is not shielded by the heat shield **27** is heated by residual heat from the halogen heater pair **23**. Accordingly, as the recording medium P is conveyed through the fixing nip N by the fixing belt **21** rotating forward in the rotation direction R**3**, the recording medium P draws heat from the fixing belt **21**, preventing substantial temperature variation and uneven temperatures of the fixing belt **21** that may result in deformation of the fixing belt **21**. The preset forward rotation time Ta of the fixing belt **21** is a time long enough for the entire circumferential length of the fixing belt **21** to pass through the fixing nip N to allow the recording medium P to draw heat from the fixing belt **21**. Additionally, the preset forward rotation time Ta of the fixing belt **21** is long enough for the pressing roller **22** to draw heat from the fixing belt **21** after the recording medium P is discharged from the fixing nip N. For example, the preset forward rotation time Ta of the fixing belt **21** is equivalent to a time taken for the fixing belt **21** to rotate for one cycle. The fixing belt **21** is rotated forward in the rotation direction R**3** at a decreased linear velocity to facilitate heat conduction from the fixing belt **21** to the recording medium P so as to reduce temperature variation of the fixing belt **21**.

With reference to FIG. **17**, a description is provided of an operation of the fixing device **20** if the recording medium sensor **29** does not detect the recording medium P when the fault occurs.

FIG. **17** is a timing chart illustrating operation of the components of the fixing device **20** when the recording medium sensor **29** does not detect the recording medium P. Upon receipt of a fault detection signal indicating a fault occurring in the image forming apparatus **1**, the controller **90** depicted in FIG. **4** turns off the halogen heater pair **23** and then the heater relay. After the heater relay is turned off, the controller **90** performs brake control to the fixing motor **92** for a preset time Tb to halt the pressing roller **22** and the fixing belt **21**. After forcefully halting the fixing motor **92** for a preset time Tc, the controller **90** rotates the fixing motor **92** backward for a preset backward rotation time Td and halts the fixing motor **92**. Thereafter, the pressurization assembly **60** that has pressed the pressing roller **22** against the fixing belt **21** releases pressure between the pressing roller **22** and the fixing belt **21** as shown in FIG. **12**A. Upon completion of the processes described above, the alarm **91** provided in the image forming apparatus **1** issues an alarm that alarms the user about the fault occurring in the image forming apparatus **1**. After the alarm **91** alarms the user about the fault, the controller **90** prohibits the user from using the fixing device **20**. During a series of processes described above, the heat shield **27** is retained at the position where the heat shield **27** is situated when the fault occurs.

The fixing belt **21** is rotated backward in a direction counter to the rotation direction R**3** after the halogen heater pair **23** is turned off because the recording medium P may be wound around the fixing belt **21** if the fixing belt **21** rotates forward in the rotation direction R**3**. If the recording medium P is wound around the fixing belt **21**, it is difficult for the user to remove the recording medium P from the fixing device **20**. Moreover, if a rigid recording medium P such as thick paper is wound around the fixing belt **21**, the rigid recording medium P may damage the fixing belt **21**. To address this circumstance, the fixing belt **21** is rotated backward in the direction counter to the rotation direction R**3** after the halogen heater pair **23** is turned off, thus preventing the recording medium P from being wound around the fixing belt **21**.

Similar to the case described above in which the recording medium sensor **29** detects the recording medium P, while the fixing motor **92** rotates backward, the unshielded region on the direct heating span α of the fixing belt **21** which is not shielded by the heat shield **27** is heated by residual heat from the halogen heater pair **23**. In this case also, as the controller **90** performs brake control to the fixing motor **92** and the fixing belt **21** rotates backward in the direction counter to the rotation direction R3, the fixing belt **21** conveys the recording medium P through the fixing nip N in a direction counter to the recording medium conveyance direction A1 depicted in FIG. **2**. Accordingly, the recording medium P draws heat from the fixing belt **21**, preventing substantial temperature variation and uneven temperatures of the fixing belt **21** and therefore preventing deformation of the fixing belt **21**. Due to a reason similar to the reason described above in the case in which the recording medium detector **29** detects the recording medium P, the preset backward rotation time Td of the fixing belt **21** is equivalent to a time taken for the fixing belt **21** to rotate for one cycle. Due to a reason similar to the reason described above in the case in which the recording medium detector **29** detects the recording medium P, the fixing belt **21** is rotated backward in the direction counter to the rotation direction R3 at a decreased linear velocity.

As shown in FIG. **17**, before rotating the fixing motor **92** backward, the controller **90** performs brake control to the fixing motor **92** and forcefully halts the fixing motor **92** so as to prevent breakage of the fixing motor **92** as the fixing motor **92** having rotated forward starts rotating backward. If the fixing motor **92** is capable of switching from forward rotation to backward rotation without brake control and forceful halting, it is not necessary for the controller **90** to perform brake control and forceful halting on the fixing motor **92**.

By employing the processes shown in FIGS. **16** and **17**, if a fault occurs in the image forming apparatus **1**, the controller **90** halts the fixing device **20** and the image forming apparatus **1** quickly regardless of whether or not the recording medium detector **29** detects the recording medium P, thus reducing damage to the components incorporated in the image forming apparatus **1**. Additionally, the processes shown in FIGS. **16** and **17** prevent uneven temperatures of the fixing belt **21** and resultant deformation of the fixing belt **21**. Even if the fixing belt **21** deforms, the halted heat shield **27** does not slide over the fixing belt **21**, preventing abrasion of the heat shield **27** and the fixing belt **21**.

According to the processes shown in FIGS. **16** and **17**, the pressurization assembly **60** having pressed the pressing roller **22** against the fixing belt **21** releases pressure between the pressing roller **22** and the fixing belt **21** after the fixing belt **21** halts. It is because, if the user tries to remove the jammed recording medium P from the fixing nip N while the pressing roller **22** presses against the fixing belt **21**, the recording medium P being pulled from the fixing nip N may damage the fixing belt **21** and the pressing roller **22** or may be torn, hindering the user from removing the jammed recording medium P from the fixing device **20**. Conversely, if the pressurization assembly **60** brings the pressing roller **22** into contact with the fixing belt **21** with no pressure therebetween or isolates the pressing roller **22** from the fixing belt **21** before the fixing belt **21** halts, the fixing belt **21** may slip and overheat locally, resulting in deformation of the fixing belt **21**.

According to the processes shown in FIGS. **16** and **17**, the alarm **91** alarms the user about the fault after operation of all the components shown in FIGS. **16** and **17** is completed.

A description is provided of the reasons to do so.

As the alarm **91** alarms the user about a fault, the user opens an exterior cover of the image forming apparatus **1** and starts a process to eliminate a cause of the fault, for example, to remove the jammed recording medium P from the fixing nip N of the fixing device **20**. As the user opens the exterior cover of the image forming apparatus **1**, an interlock switch is turned off for safety. Accordingly, all the drivers installed in the image forming apparatus **1** including the fixing motor **92** are halted forcefully. If the alarm **91** alarms the user about the fault immediately after the halogen heater pair **23** is turned off, the user opens the exterior cover before the fixing motor **92** starts rotating forward and backward to dissipate heat and therefore the fixing belt **21** may be halted forcefully, resulting in substantial temperature variation of the fixing belt **21**. Further, the pressing roller **22** and the fixing belt **21** are also halted forcefully while the pressing roller **22** presses against the fixing belt **21**. Accordingly, if a recording medium P is sandwiched between the fixing belt **21** and the pressing roller **22**, the user may pull the recording medium P with a substantial force which may damage the fixing belt **21** and the pressing roller **22**. Further, the user may not remove the jammed recording medium P from the fixing nip N.

To address those problems, according to the exemplary embodiments described above, the alarm **91** alarms the user about the fault after operation of all the components shown in FIGS. **16** and **17** is completed, that is, after the halogen heater pair **23** is turned off, the fixing belt **21** is rotated forward or backward, and the pressurization assembly **60** having pressed the pressing roller **22** against the fixing belt **21** releases pressure between the pressing roller **22** and the fixing belt **21**, thus preventing the problems described above.

After the cause of the fault is eliminated, for example, after the user finishes removal of the jammed recording medium P from the fixing device **20**, the image forming apparatus **1** is turned on for recovery. FIG. **18** is a timing chart illustrating processes performed by the components of the fixing device **20** as the image forming apparatus **1** is turned on for recovery. Upon receipt of a recovery signal indicating the fault is eliminated, the heat shield **27** returns to the home position shown in FIG. **13**A and at the same time the pressurization assembly **60** presses the pressing roller **22** against the fixing belt **21** as shown in FIG. **12**B. Thereafter, the fixing motor **92** is driven to rotate the fixing belt **21** and then the heater relay and the halogen heater pair **23** are turned on, rendering the image forming apparatus **1** ready for an image forming operation.

The heat shield **27** moves to the home position shown in FIG. **13**A before the halogen heater pair **23** is turned on. It is because, if the halogen heater pair **23** is turned on while the heat shield **27** is retained at the position where the heat shield **27** is situated when the fault occurs, the heat shield **27** may shield the fixing belt **21** in a part of the direct heating span α thereof, causing substantial temperature variation and uneven temperatures of the fixing belt **21** which may result in deformation of the fixing belt **21**. To address this circumstance, the halogen heater pair **23** is turned on while the heat shield **27** is at the home position, allowing the halogen heater pair **23** to heat the fixing belt **21** evenly throughout the direct heating span α thereof.

As shown in FIG. **18**, the heat shield **27** returns to the home position shown in FIG. **13**A and at the same time the pressurization assembly **60** presses the pressing roller **22** against the fixing belt **21**. Alternatively, the heat shield **27** may return to the home position before or after the pressurization assembly **60** presses the pressing roller **22** against the fixing belt **21** as long as the heat shield **27** returns to the home position and the pressurization assembly **60** presses the pressing roller **22** against the fixing belt **21** before the fixing motor **92** starts rotation.

With reference to FIG. **19**, a description is provided of processes to return the heat shield **27** to the home position shown in FIG. **13**A as the image forming apparatus **1** is turned on for recovery.

FIG. **19** is a flowchart showing such processes. As shown in FIG. **19**, in step S**1**, the controller **90** receives a recovery signal. In step S**2**, upon receipt of the recovery signal, the controller **90** controls the heat shield driver **46** to pivot the heat shield **27** in the backward second pivot direction X**2**, thus moving the heat shield **27** to the home position shown in FIG. **13**A. In step S**3**, the controller **90** determines whether or not the home position sensor **55** outputs a high signal. If the controller **90** determines that the home position sensor **55** does not output the high signal (NO in step S**3**), in step S**4**, the controller **90** determines whether or not the home position sensor **55** outputs the high signal when a preset time elapses after the controller **90** determines that the home position sensor **55** does not output the high signal in step S**3**. If the controller **90** determines that the home position sensor **55** does not output the high signal and therefore outputs a low signal (NO in step S**4**), in step S**5**, the controller **90** determines that a fault occurs and sends an alarm signal to the alarm **91**. In step S**6**, the alarm **91** issues an alarm that alarms the user about the fault.

A fault may occur while the heat shield **27** is at the home position shown in FIG. **13**A. In this case also, the heat shield **27** is retained at the home position. Accordingly, as the image forming apparatus **1** is turned on for recovery, it is not necessary to move the heat shield **27**, facilitating early detection of the heat shield **27** at the home position and resulting in quick recovery of the image forming apparatus **1**.

The present invention is not limited to the details of the exemplary embodiments described above, and various modifications and improvements are possible. For example, instead of the fixing belt **21**, a hollow tubular roller or a solid roller may be used as a fixing rotary body. The shape of the heat shields **27** and **27**S is not limited to those shown in FIGS. **8** and **10**. For example, although the shield portion **48** of the heat shield **27** has a single step as shown in FIG. **8** and the shield portion **48**S of the heat shield **27**S has two steps as shown in FIG. **10**, a heat shield having three or more steps may be used according to the size of the recording medium P.

A description is provided of advantages of the fixing devices **20** and **20**S.

As shown in FIGS. **2**, **4**, **7**, and **10**, the fixing devices **20** and **20**S include a fixing rotary body (e.g., the fixing belt **21**) rotatable in the rotation direction R**3**; a heater (e.g., the halogen heater pair **23**) to heat the fixing rotary body; an opposed body (e.g., the pressing roller **22**) contacting an outer circumferential surface of the fixing rotary body to form the fixing nip N therebetween through which a recording medium P is conveyed; a heat shield (e.g., the heat shields **27** and **27**S) interposed between the heater and the fixing rotary body and movable in a circumferential direction of the fixing rotary body to shield the fixing rotary body from the heater in a variable circumferential direct heating span of the fixing rotary body where the heater is disposed opposite the fixing rotary body directly; a heat shield driver (e.g., the heat shield driver **46**) connected to the heat shield to drive and move the heat shield; and a controller (e.g., the controller **90**) operatively connected to the heat shield driver to control the heat shield driver to halt the heat shield instantly as a fault occurs during a print job.

Accordingly, even if the image forming apparatus **1** stops urgently, the controller halts the fixing device quickly, reducing damage to the components including the fixing rotary body which are incorporated in the fixing device.

As shown in FIGS. **8** and **10**, the shield portions **48** and **48**S are disposed at both lateral ends of the heat shields **27** and **27**S in the longitudinal direction thereof, respectively. Alternatively, the shield portions **48** and **48**S may be disposed at one lateral end of the heat shields **27** and **27**S in the longitudinal direction thereof, respectively. In this case, the recording medium P is conveyed over the fixing belt **21** along one lateral edge of the fixing belt **21** in the axial direction thereof and the shield portions **48** and **48**S are disposed in proximity to another lateral edge of the fixing belt **21** in the axial direction thereof.

According to the exemplary embodiments described above, the fixing belt **21** serves as a fixing rotary body. Alternatively, a fixing roller or the like may be used as a fixing rotary body. Further, the pressing roller **22** serves as an opposed body. Alternatively, a pressing belt or the like may be used as an opposed body.

The present invention has been described above with reference to specific exemplary embodiments. Note that the present invention is not limited to the details of the embodiments described above, but various modifications and enhancements are possible without departing from the spirit and scope of the invention. It is therefore to be understood that the present invention may be practiced otherwise than as specifically described herein. For example, elements and/or features of different illustrative exemplary embodiments may be combined with each other and/or substituted for each other within the scope of the present invention.

What is claimed is:

1. An image forming apparatus comprising:

a fixing device including:

- a fixing rotary body rotatable in a predetermined direction of rotation;
- a heater disposed opposite and heating the fixing rotary body;
- an opposed body to contact the fixing rotary body with releasable pressure therebetween to form a fixing nip therebetween through which a recording medium is conveyed;
- a heat shield interposed between the heater and the fixing rotary body and movable in a circumferential direction of the fixing rotary body to shield the fixing rotary body from heat radiated from the heater in a variable circumferential direct heating span of the fixing rotary body where the heater is disposed opposite the fixing rotary body directly; and
- a controller operatively connected to the heater and the heat shield to halt the heat shield instantly when a fault occurs during a print job.

2. The image forming apparatus according to claim **1**, wherein the controller moves the heat shield to a home position where the heat shield is disposed opposite the heater indirectly when the fault is eliminated.

3. The image forming apparatus according to claim **1**, further comprising a recording medium detector operatively connected to the controller and disposed downstream from the fixing nip in a recording medium conveyance direction to detect the recording medium.

4. The image forming apparatus according to claim **3**, wherein the fixing rotary body rotates forward in the predetermined direction of rotation after the controller turns off the heater as the recording medium detector detects the recording medium when the fault occurs.

5. The image forming apparatus according to claim **4**, wherein, when the fault occurs, the fixing rotary body rotates forward in the predetermined direction of rotation at a linear velocity slower than a linear velocity at which the fixing rotary body rotates during the print job.

6. The image forming apparatus according to claim **5**, wherein the pressure between the opposed body and the fixing rotary body is released after the fixing rotary body halts after the fixing rotary body rotates forward in the predetermined direction of rotation.

7. The image forming apparatus according to claim **6**, further comprising an alarm operatively connected to the controller to issue an alarm after the pressure between the opposed body and the fixing rotary body is released.

8. The image forming apparatus according to claim **3**, wherein the fixing rotary body rotates backward in a direction counter to the predetermined direction of rotation after the controller turns off the heater as the recording medium detector does not detect the recording medium when the fault occurs.

9. The image forming apparatus according to claim **8**, wherein, when the fault occurs, the fixing rotary body rotates backward in the direction counter to the predetermined direction of rotation at a linear velocity slower than a linear velocity at which the fixing rotary body rotates during the print job.

10. The image forming apparatus according to claim **9**, wherein the pressure between the opposed body and the fixing rotary body is released after the fixing rotary body halts after the fixing rotary body rotates backward in the direction counter to the predetermined direction of rotation.

11. The image forming apparatus according to claim **10**, further comprising an alarm operatively connected to the controller to issue an alarm after the pressure between the opposed body and the fixing rotary body is released.

12. The image forming apparatus according to claim **1**, further comprising a position detector operatively connected to the controller and linked with the heat shield to detect a position of the heat shield.

13. The image forming apparatus according to claim **12**, wherein the position detector includes:

a feeler connected to the heat shield and pivotable in the circumferential direction of the fixing rotary body in accordance with movement of the heat shield;

a home position sensor defining a home position where the heat shield is disposed opposite the heater indirectly to detect the feeler as the feeler overlaps the home position sensor; and

an angle sensor disposed downstream from the home position sensor in the direction of rotation of the fixing rotary body to detect the feeler as the feeler overlaps the angle sensor, the angle sensor defining a reference position of the heat shield.

14. The image forming apparatus according to claim **13**,

wherein the angle sensor is positioned relative to the home position sensor to form a phase angle with the home position sensor, and

wherein the feeler includes a fan having a central angle smaller than the phase angle formed by the angle sensor with the home position sensor.

15. The image forming apparatus according to claim **13**, wherein the controller moves the heat shield from the reference position to a shield position where the heat shield is disposed opposite the heater directly to shield the fixing rotary body from the heater.

16. The image forming apparatus according to claim **1**, wherein the fixing rotary body includes an endless belt, the opposed body includes a pressing roller, and the heat shield includes a metal plate.

17. An image forming method comprising:

rotating a fixing rotary body forward at an increased linear velocity to convey a recording medium through a fixing nip formed between the fixing rotary body and an opposed body contacted by the fixing rotary body with pressure therebetween;

moving a heat shield to a shield position where the heat shield shields the fixing rotary body from heat radiated from a heater;

detecting a fault;

detecting the recording medium discharged from the fixing nip;

turning off the heater;

rotating the fixing rotary body forward at a decreased linear velocity for a preset time;

halting the fixing rotary body;

releasing the pressure between the fixing rotary body and the opposed body; and

issuing an alarm about the fault.

18. The image forming method according to claim **17**, further comprising:

receiving a recovery signal indicating the fault is eliminated;

moving the heat shield to a home position where the heat shield does not shield the fixing rotary body from the heater;

pressing the opposed body against the fixing rotary body;

rotating the fixing rotary body forward; and

turning on the heater.

19. An image forming method comprising:

rotating a fixing rotary body forward at an increased linear velocity to convey a recording medium through a fixing nip formed between the fixing rotary body and an opposed body contacted by the fixing rotary body with pressure therebetween;

moving a heat shield to a shield position where the heat shield shields the fixing rotary body from a heater;

detecting a fault;

detecting no recording medium discharged from the fixing nip;

turning off the heater;

halting the fixing rotary body for a preset first time;

rotating the fixing rotary body backward for a preset second time;

halting the fixing rotary body;

releasing the pressure between the fixing rotary body and the opposed body; and

issuing an alarm about the fault.

20. The image forming method according to claim **19**, further comprising:

receiving a recovery signal indicating the fault is eliminated;

moving the heat shield to a home position where the heat shield does not shield the fixing rotary body from the heater;

pressing the opposed body against the fixing rotary body;

rotating the fixing rotary body forward; and

turning on the heater.

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